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LUNAR AND PLANETARY INSTITUTE

Semi-Annual Status Report

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1 July 1984 - 31 December 1984



UNIVERSITIES SPACE RESEARCH ASSOCIATION

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Respectfully submitted,

31 May 1985

Date

Kevin Burke, Director
Lunar and Planetary Institute

2 June 1985

Date

Paul J. Coleman, Jr., President
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INTRODUCTION

This report covers the scientific and administrative activities at the Lunar and Planetary Institute during the period 1 July 1984 through 31 December 1984.

During the period 1 July 1984 through 31 December 1984 the Institute was under the direction of Dr. Kevin Burke, Director.

This report has been prepared and submitted by the Staff of the Office of the Director, LPI.

ACTIVITIES AT THE LUNAR AND PLANETARY INSTITUTE FOR PERIOD

1 JULY 1984 - 31 DECEMBER 1984

A. PLANETARY IMAGE CENTER (PIC)

The Planetary Image Center (PIC) is part of the Planetary Geology Program's network of Regional Planetary Image Facilities. As such, PIC maintains an up-to-date reference and working collection of planetary images and support data; disseminates information through an active interlibrary loan program; provides planetary slide sets at cost; conducts annual open houses; assists scientists, students, and educators in acquiring access to, or loan of, image products; and provides daily reference services to users both in house and throughout the country. Requests for materials were received from the scientific community and a variety of users, including publishers of textbooks, popular books, and magazines, film producers, planetarium and museum directors, students, and teachers.

Materials on loan or purchased from the Image Center during this reporting period are as follows:

On Loan

Photographs	2041	Transparencies	176
Maps	81	Rolls of Transparencies	68
Slides	495	Globes	2
Movies	18		

New acquisitions included 57 maps.

Our darkroom facility continues to handle small-volume requests in a timely manner. In addition to providing custom prints for photo interpretation and routine prints for other departments at the Institute, the facility produces slides for the in-house scientific staff for use in lectures. Twenty work requests were processed by JSC, while 82 were processed in house.

During this reporting period, approximately 150 inquiries were received at PIC.

PIC's staffing (as of September) consists of an acting Manager, a part-time Assistant and a part-time Darkroom Technician.

B. LIBRARY INFORMATION CENTER (LIC)

The Library Information Center continues to be a source of information for our staff, scientists at JSC and neighboring universities, and to the . . research community and public who utilize our services through letters and telephone calls.

There has been continued interest in remote and personal access to the Lunar and Planetary Bibliography, which has been made possible through the development of SEARCH. There is active use by the Planetary Materials Branch at JSC, students at University of Houston and Rice, and users in the U.S. and foreign countries who query us by letter or telephone.

During July and August personnel from LIC presented a short history of the LPI and presented various sources of educational materials to the Aerospace Education Workshop group, a NASA-University of Houston special course for U.S. teachers teaching in foreign countries. On July 19, personnel from LIC and PIC hosted a group from the Texas A&M Gifted and Talented Children's Program. After lectures about the Institute and a slide show presentation on the solar system, the children were given a guided tour of the LIC and Pic and a demonstration of the Imaging Processing Facility. This group is led by Mrs. June Scobee.

In August, LIC personnel worked with Ms. Debbie Fischer who was completing the necessary forms to have the West Mansion included in the American Society of Interior Design's Directory of Famous Architecture. History of the building, description of early furnishings, and pictures of the Institute were supplied to Ms. Fischer.

A total of 92 searches were run during this period; 84 were done on the in-house data base and 8 on commercial data bases. This brings the annual total to 228 searches; 32 of them on commercial data bases.

Three hundred and twenty-five citations were added to the Lunar and Planetary bibliography during this period. This brings the total number of citations in the Lunar and Planetary bibliography to approximately 21,000.

Circulation records maintained for this reporting period show an average monthly circulation of 450 items to an average of 78 users.

Requests for LPI Technical Reports and special Contributions which are abstract volumes for topical conferences, totaled 101 requests for 155 publications.

During this period, 18 LPI Contributions were processed for distribution. (See Appendix IV)

One issue of the Bulletin was published during this reporting period. The November issue, number 39, contained the preliminary announcement for the 16th Lunar and Planetary Science Conference, news of other topical conferences and meetings of interest to our community, and the regular

features of news items, new publications, calendar of events, and current awareness bibliography. Total circulation of the Bulletin now exceeds 4700.

During the calendar year 1984, 349 names were added to the LPI mailing list.

C. COMPUTER CENTER

The Computer Center continued its steady growth during this reporting period. VMS version 3.7 was installed on the LPI VAX 11/780 to provide improved system performance. Two issues of the C2PDA newsletter went out to more than 1000 scientists to familiarize the user community with the facilities at LPI. (See Appendix V.)

Image Processing Facility (IPF)

LIPS version 3.5 image processing software was installed on the Gould IP8500 system to provide enhanced image processing functions. In addition, the in-house programming staff developed programs to co-register images and the mosaicing program was totally revised to handle a variety of images. A new version of VICAR was also installed on the VAX for manipulation of images that are greater than 512 by 512 pixels. With increased usage of the IPF, a high resolution hardcopy output device was found lacking. Plans to acquire an Optronics 4300 Colorwrite system was underway to complement the state-of-the-art interactive image processing aspects of IPF.

Geophysical Data Facility (GDF)

The modelling programs for the GDF were further developed so that users can model using point mass, curve disks, flat disks, spherical harmonics for Venus and Mars line of sight gravity data. A batch mode of using GDF was also developed so that after a user has selected the modelling criteria interactively, he/she can submit the task and disconnect to save on telephone charges. The plotting package was expanded so that GDF would support both Tektronics Plot 10 compatible graphics terminals as well as DEC REGIS compatible terminals. A remote demo was set up at the Water on Mars Conference at Ames Research Center on November 30-December 1, and again in San Francisco the following week in conjunction with the AGU. Response was very encouraging and we had several new users on the system, as a result.

Research Projects

The computer system was heavily used by various staff and visiting scientists as well as summer interns. Work was carried out on planetary modelling, spherical harmonics modelling for Venus gravity, isostatic compensation modelling of Venus gravity data, gravity and magnetic anomaly field data for the Earth and the terrestrial planets, modelling of formation of duricrust on the surface of Mars, modelling of elastic plate

tectonic load response to Lake Bonneville, surface morphology on the Martian volcano Ascræus Mons, investigation on the morphology and distribution of Martian narrow valley channels, and analysis of ejecta trajectory in impact crater experiments under different atmospheric conditions.

Research-related Activities

The LPI computer system also provided computer and word processing support to various departments in research support areas and to Institute related administrative functions. In all, nine departments in the Institute utilized the VAX 11/780 computer system in various aspects of their operation. Complete on-line log-in process of the 15th Lunar and Planetary Science Conference and the subsequent publication of the Proceedings volumes was performed on the LPI system. The computer was used in the information retrieval in the lunar and planetary bibliography search maintained by the library; in BIRP, the on-line information retrieval of Viking images; in the computerized subject index search of the slides and maps collection of the Planetary Image Center; and in the maintenance of the world directory of lunar and planetary scientists and laboratories.

Staff

The Computer Center was operated with a technical staff under the Computer Systems Manager, with LPI scientists acting as scientific advisors to different facilities within C2PDA. They included the Computer Systems Manager, a Scientific Programmer/Analyst (IPF), a Scientific Programmer/Analyst (GDF), a Programmer/User Support and a temporary Scientific Programmer (GDF).

D. PRODUCTION SERVICES

Upgrade of the department's typesetting system continued during this reporting period. The EPICS front end typesetting computer was installed and is now handling all Institute typesetting. The CompEdit 5810 photomechanical typesetter was replaced with Varityper's 6100 digital slave typesetter that sets copy 3 1/2 times faster than the photomechanical system. Copy quality is also much improved by the sharper resolution of the digital type. All fonts that were available on the old system have been converted to digital type and are now on-line on the EPICS typesetting system. Winchester disk capacity has been expanded from 10 to 15 megabytes. In addition, new telecommunications software has been installed allowing the typesetting computer to send and receive data by cable connection with the Institute VAX and by phone connection with remote users. This software is currently being modified by the department to suit specific frequent-user needs.

The department produced 462 pieces of artwork for scientists and staff during the reporting period as well as 15 larger projects, including journal articles, reports, brochures, extended programs and the like. In

addition, the typesetting office produced 46 camera-ready articles for contributors to the 15th Lunar and Planetary Science Conference proceedings, and, on a charge-back, non-interference basis, a camera-ready proceedings volume for USRA's Division of Space Biomedicine. . .

E. SCIENTIFIC STAFF

In addition to the Director, the in-house scientific staff (during this report period) consisted of five scientists working in different areas of lunar and planetary research and assisting in implementation of service functions of the Institute -- names and areas of activity are as follows:

Dr. Kevin Burke -- Geology -- Research in the application of the findings of plate tectonics to interpretation of the geological history of the earth. Currently pursuing research on the operation of the Wilson cycle of the opening and closing of oceans on earth, concentrating on: 1) Caribbean evolution over the last 200 my; 2) the way this cycle operated to make early crust in the Archean.

Dr. Lewis D. Ashwal -- Petrology/Geochemistry -- Origin and evolution of planetary crusts and mantles; Precambrian geologic history; petrology, mineralogy, and geochemistry of anorthosites and related rocks; origin of magmatic ore deposits; role of volatiles in igneous and metamorphic processes; Rb-Sr and Sm-Nd isotope geochronology; fluid inclusion studies; meteorites as possible martian samples. Serves as Project Scientist for the LPI project: Early Crustal Genesis of the Terrestrial Planets.

Dr. Bruce Bills -- Planetary Geophysics -- determination and interpretation of global scale planetary gravity and topography, with emphasis towards tectonic processes (mostly thermal) and attention to terrestrial problems. Plays key role in the expansion of the Geophysical Data Facility.

Dr. Paul Morgan -- Geophysics -- Research in heat flow and seismic studies in active tectonic environments; the genesis, structure, and evolution of continental rifts, and geothermal systems. Served as Project Scientist for the LPI project on continental rifts. Chairman of the LPI Seminar Series to early August 1984.

Dr. Graham Ryder -- Geology -- Research in igneous petrology, planetology - petrographic, petrochemical, microprobe studies with emphasis on origin of cumulate rocks and lunar crustal development. Co-Editor of the Proceedings of the 15th and 16th Lunar and Planetary Science Conferences. Member of the Lunar and Planetary Sample Team.

Dr. Peter H. Schultz -- Planetary Geology -- Problems in atmospheric effects of impact crater formation; emplacement mechanics of ejecta on the Moon and Mars; experimental impact cratering; structure and evolution of multi-ring impact basins; martian polar wandering; computer-code simulation of impact cratering. Serves as LPI Science Coordinator for the NASA/Ames Vertical Ballistic Gun Range. LPI representative on Regional Planetary-Image Facility Committee and Science Advisor for Planetary Image Center at LPI to early September 1984. Chairman of the "Working Group for the Preservation of Planetary Products." Member of Mars Data Analysis Panel. Chairman of the in-house Visiting Scientist Review Panel to early September 1984.

The in-house scientific staff members are of vital importance in their service roles in LPI programs and activities, and also as experienced lunar and planetary scientists who help in initiating and formulating new programs using their research experience. In this context, the resident staff and both long- and short-term visiting scientists have been jointly active in phases of program development and implementation requiring broad scientific expertise.

Further details on scientific staff and long-term visitor appointments and publications and on off-site scientific and/or programmatic activities (during the report period) are given in Appendices I.A. and I.C.

F. VISITOR PROGRAM

LPI visitors are classified into six major categories: Visiting Scientists (VS), Visiting Research Scientists (VRS), Visiting Post-Doctoral Fellows (VPDF), Visiting Graduate Fellows (VGF), Visiting Undergraduate Fellows (VUF), and Visiting Undergraduate Interns (VUI). At any one time the facility can accommodate approximately 25 visitors. During the period 1 July 1984 - 31 December 1984, 35 visitors will have been in residence at LPI for a combined total of about 4.15 man-years. The visitor group consisted of 8 Visiting Scientists, 3 Visiting Post-Doctoral Fellows, 9 Visiting Graduate Fellows, 1 Visiting Undergraduate Fellow and 14 Visiting Undergraduate Interns. A summary of the level of effort, accomplishments, and costs for each category is shown in the Table that follows:

SUMMARY OF VISITOR PROGRAM*
July 1, 1984 - December 31, 1984

CATEGORY	NO. OF PERSONS	TOTAL MAN YRS.	AVERAGE LENGTH OF STAY (WEEKS)	COSTS	
				SALARY	TRAVEL, RE- LOCATION & DISLOCATION EXPENSES
Domestic V.S.	7	.03	.23	546.00	483.28
Foreign V.S.	1	.01	.57	-0-	225.68
V.P.D.F.	3	1.17	20.24	27,943.12	4,153.04
V.G.F.	9	.84	4.86	-0-	3,590.00
V.U.F.	1	.20	10.14	-0-	3,000.00
V.U.I. (Summer Interns)	14	1.90	7.07	-0-	27,306.96
TOTALS	35	4.15		\$28,489.12	\$38,758.96

*See Appendix I.B for Visitor Roster

Summer Undergraduate Intern Program

In the Summer of 1984, the Lunar and Planetary Institute offered students world-wide an opportunity to work closely with scientists active in lunar and planetary research. Out of 200 highly qualified applicants from throughout the United States, Canada, Germany, Italy, Japan and the United Kingdom, fourteen undergraduate or newly-graduated students were chosen to take part in the eighth Summer Undergraduate Intern Program. Scientists from the Lunar and Planetary Institute and the NASA Johnson Space Center are directing the interns in a variety of research projects. Interns will have opportunities to present a profile of their research to their colleagues and advisors, and to interact with scientists from JSC, LPI, and with visiting researchers from the lunar and planetary science community. It is anticipated that many of these projects and interactions will produce publishable results. A roster of students and their advisors is included in Appendix I.B.

G. SCIENTIFIC PROJECTS, CONFERENCES, WORKSHOPS, AND SEMINARS

1. Topical Conferences, Workshops, and Seminars

Conferences, workshops and special projects on various subjects are arranged and conducted in-house by LPI. Available facilities can accommodate approximately 75 participants for discussion conferences; however, LPI can accommodate larger groups through closed-circuit television. Television monitors and audio system in the Hess Room allow remote auditing of presentations (one sound and two video inputs) from the Berkner Room.

Summary tables of conferences, workshops and seminars are contained in Appendix II.

Solar System Science on Space Station

Numerous studies are being undertaken to identify the potential science that could be conducted in the unique environment afforded by a space station. The Lunar and Planetary Institute is forming a steering committee, chaired by Dr. Ronald Greeley of Arizona State University, for the purposes of: providing communication among the various workshops and study groups; providing a common focus for information and supply data to studies such as the SESAC Task Force on the Space Station; and organizing a science conference in early 1986. Invitations have been issued to the scientists who will make up the steering committee which is expected to have its first of two FY 1985 meetings on January 18, 1985, at Arizona State University.

Study Project on "Mars: The Evolution of its Climate and Atmosphere (MECA)"

Continuing activities of the MECA Study Project included the distribution of MECA Newsletter 2 and an LPI sponsored workshop entitled "Water on Mars". The editor of the second (September 1984) and future newsletters is Dr. Stephen Clifford, LPI Staff Scientist. A complete report on the "Water on Mars" Workshop and information concerning two upcoming workshops "Dust on Mars" and "Evolution of the Martian Climate" are provided in this report. (See Appendix VI.) Special sessions on the MECA Study Project were held at the GSA meeting in Reno, Nevada, in November 1984 and at the 1984 Fall AGU meeting held in San Francisco in December 1984.

Early Crustal Genesis Project (ECG)

Additional conferences and workshops have resulted from the ECG Project. A topical conference "Origin of the Moon" was held in October 1984 and a field workshop "The Earth's Oldest Rocks" will be held in west Greenland the last two weeks in June 1985. Additional details on these meetings are provided in this report.

Lunar Base Study Project

The Steering Committee for the Lunar Base Study Project held meetings July 16-17, 1984, in Washington, D.C., and September 17-18, 1984, at the Lunar and Planetary Institute. The primary purpose of both meetings was to organize and plan the program for the Symposium on Lunar Bases and Space Activities of the 21st Century which was held October 29-31, 1984, at the National Academy of Science in Washington, D.C. The Steering Committee Chairman, Dr. Michael B. Duke of NASA Johnson Space Center, served as the convener for the symposium. Details concerning the meeting are included in this report. The Lunar and Planetary Institute is providing management for the steering committee whose purpose is raising the consciousness of the general community of the potential benefits of a lunar base.

Space Station Automation and Robotics Panel

A meeting of the NASA Space Station Automation and Robotics Panel will be hosted by the Lunar and Planetary Institute January 17-18, 1985. The NASA sponsored panel is being administered by Dr. David R. Criswell, California Space Institute, University of California. The LPI will assist Dr. Criswell by providing staffing and coordination of logistics for the workshop. Attendance is expected to include 38 members of the base working group as well as an additional 40 scientists interested in the wide range of topics encompassed by the fields of automation and robotics and the effort to identify major opportunities for applying new technologies and hardware to the planning of the Space Station.

"Dust on Mars" Workshop

Arizona State University will host a small workshop "Dust on Mars" February 4-5, 1985, as an activity of the MECA Study Project. The Lunar and Planetary Institute is sponsoring the workshop being convened by Steven Lee, Arizona State University. This workshop will be held to stimulate and coordinate research into processes affecting yearly deposition, erosion, and transport of dust on Mars. It is expected that abstracts submitted for the workshop will be compiled in an LPI Technical Report following the meeting.

16th Lunar and Planetary Science Conference

The Sixteenth Lunar and Planetary Science Conference is being organized under the sponsorship of the NASA Johnson Space Center, the Lunar and Planetary Institute, The American Geophysical Union, the Division for Planetary Science, of the American Astronomical Society, the Meteoritical Society, the Geological Society of America and the International Union of Geological Sciences. The conference will be held March 11-15, 1985 at the NASA Johnson Space Center, Houston, Texas. Abstracts submitted for presentation and accepted by the program committee will be designated for oral or poster presentation or for print only in the abstract volumes published by LPI. The program committee is scheduled to meet in January 1985, to review contributions and to organize details of the conference program. During the four-and-a-half-day conference three sessions will run concurrently each half-day for oral presentations.

Workshop on "The Earth's Oldest Rocks"

A field workshop on "The Earth's Oldest Rocks" will be held in the Godthaab district of west Greenland, June 19-30, 1985. The meeting will be sponsored by agencies in the U.S., Denmark, and Greenland, including the National Aeronautics and Space Administration, the Lunar and Planetary Institute, the National Science Foundation, the Commission for Scientific Research in Greenland, and the Greenland Geological Survey. The objective is to bring together scientists in terrestrial and planetary geochemistry, geology, and geophysics to examine first-hand the earliest terrestrial crust available as a contribution to the Early Crustal Genesis Study.

Project (ECG). Due to very complex logistics involved as well as space limitations on the boats and aircraft to be used for the field trip, only 30 persons will be invited to participate. Applications for attendance will be reviewed by the organizers to select participants on the basis of who is likely to contribute to or benefit most from the workshop. The field excursions will be led by Drs. Victor McGregor, Allen Nutman, and Clark Friend; organizers for the field workshop are Drs. Lewis Ashwal and Kevin Burke, Lunar and Planetary Institute and Dr. William Phinney, NASA Johnson Space Center. An abstract volume and field guide will be produced and distributed to attendees.

International Workshop on Antarctic Meteorites

An IAGC/LPI Symposium "International Workshop on Antarctic Meteorities" will be held at the Max-Planck-Institute fur Chemie in Mainz, Federal Republic of Germany, July 11-13, 1985. Conveners for the workshop are Dr. John O. Annexstad, NASA Johnson Space Center and Drs. Ludolf Schultz and Heinrich Wanke, Max-Planck-Institute fur Chemie. The purpose of the workshop is to discuss the state of research and program directions on the more than 8000 Antarctic meteorite fragments found by Japanese and United States search parties. Research on these meteorites has become international in scope and promises to continue to grow as more countries become involved in Antarctic and planetary science. The workshop is being held just prior to the 48th Annual Meeting of the Meteoritical Society in Bordeaux, France in order to allow as many interested scientists as possible to attend.

The 48th Annual Meteoritical Society Meeting

The 48th Annual Meeting of the Meteoritical Society will be held July 16-19, 1985, at the University of Bordeaux in France. The meeting is being organized by Dr. G. Simonoff, Universite de Bordeaux I, and will be sponsored by the Meteoritical Society, the Lunar and Planetary Institute, and the Universite de Bordeaux I. Abstracts being submitted for presentation at the meeting are due by May 10, 1985.

"Evolution of the Martian Climate" Workshop

MECA study group members will hold a workshop on "Evolution of the Martian Climate" during a two-day break of the IAMAP/IAPSO Joint Assembly being held August 5-16, 1985, in Honolulu, Hawaii. The workshop results will then be presented during a session of the IAMAP/IAPSO Assembly. The dates for the workshop are tentatively set for the August 10-11 break during the Assembly. It is expected that most of the papers presented to the IAMAP/IAPSO Joint Assembly will deal with Mars and that MECA workshop attendees will benefit by the exchange of information at the Assembly and by the participation in the workshop of invited IAMAP representatives. The LPI sponsored workshop will be convened by Drs. Michael Carr, Conway Leovy, and Robert Pepin; local organizers will be Drs. Fraser Fanale and Philip James. Abstracts submitted to the workshop will be compiled into an abstract volume by LPI for distribution at the workshop. An LPI Technical

Report including revised abstracts and a meeting summary will be published following the workshop.

Topical Conference on "Heat and Detachment in Crustal Extension on Continents and Planets"

An LPI topical conference on "Heat and Detachment in Crustal Extension on Continents and Planets" will be held October 10-12, 1985, in Sedona, Arizona. Conference conveners are Drs. Ivo Lucchitta and Larry Soderblom, USGS, Flagstaff, and Dr. Paul Morgan, Purdue University. The goal of the conference is to bring together people who can provide field, experimental and theoretical information on the subject of continental extension with the focus on specific mechanisms that are likely to play a major role in controlling the style of continental extension. The conference will be the third in a series that has already explored plateau uplift and processes of planetary rifting. A field trip is being planned following the conference to take advantage of nearby areas of interest including possible trips to the Grand Canyon and Verde Valley, or an overflight across and along the boundary between the craton (Colorado Plateau) and the adjacent Basin and Range Province. An abstract volume will be produced by LPI for distribution at the conference. Proceedings of the conference may be published in a special issue of Tectonophysics.

Workshop on "Cosmogenic Nuclides"

Dr. Robert C. Reedy, Los Alamos National Laboratory, and Dr. Peter Englert, University of Cologne, convened a workshop entitled "Cosmogenic Nuclides" which was held July 26-27, 1984 in Los Alamos, New Mexico. Forty participants from a wide range of fields attended this two-day workshop on the nuclides made by the cosmic rays. Sponsors for the workshop were the Los Alamos National Laboratory and the Lunar and Planetary Institute. A volume of abstracts submitted by participants was prepared at LPI and distributed at the meeting. A post-workshop report will be published by LPI as an edition of the Technical Report Series.

47th Annual Meteoritical Society Meeting

The 47th Annual Meteoritical Society Meeting was held July 30 - August 2, 1984, at the University of New Mexico, Albuquerque, New Mexico. The meeting was hosted by the Institute of Meteoritics, Department of Geology, of the University of New Mexico which co-sponsored the meeting with the Lunar and Planetary Institute. Additional support was provided by the Los Alamos National Laboratory. An abstract volume and formal program of presentations was produced by LPI and distributed to the 296 participants. Papers presented at the annual meeting will be published in the December issue of Meteoritics.

Conference on the Origin of the Moon

A contribution to the ECG Project was a topical conference on "The Origin of the Moon" held on October 12-16, 1984, in Kona, Hawaii. The

conference, which was sponsored by the Lunar and Planetary Institute, the Division for Planetary Sciences (DPS) and the National Aeronautics and Space Administration, was scheduled immediately following the DPS annual meeting on October 9-12, 1984. A Joint activity for the participants of both meetings was a volcano field trip on October 13, 1984. The conference was convened by Drs. William K. Hartmann of the Planetary Science Institute, Roger J. Phillips of Southern Methodist University and G. Jeffrey Taylor of the University of New Mexico. Six half-day sessions held on October 14-16 were attended by 105 scientists and 14 guests. Abstract volumes were prepared by the LPI Publications Office and distributed to the participants. A book entitled Origin of the Moon to be published by LPI is expected to be ready for distribution in early 1986.

"Lunar Bases and Space Activities of the 21st Century" Symposium

The "Lunar Bases and Space Activities of the 21st Century" Symposium as an activity of the Lunar Base Study Project was supported by the Lunar and Planetary Institute and sponsored by NASA Johnson Space Center. The symposium was held at the National Academy of Sciences in Washington D.C. October 29-31, 1984. LPI support for the meeting consisted of administrative support for the steering committee, coordination of meeting logistics and graphic services. The LPI Publication Department will publish a proceedings volume resulting from the meeting. Dr. Michael B. Duke, NASA Johnson Space Center, convened the symposium which was attended by 300 participants and 62 members of the press. The symposium provided a forum for the exchange of ideas on the uses of a base on the Moon for scientific, industrial or other purposes, the technological implications of a lunar base, the economic, political, international relations, legal and other social implications of a lunar base, and the relationship of a lunar base program to other activities in space and on Earth in the early 21st Century. Participating in the symposium were government representatives, engineers, former astronauts, socialists, architects, environmentalists, planetary scientists and representatives of several other interest groups concerned with the prospects of a lunar base.

"Water on Mars" Workshop

An LPI sponsored workshop "Water on Mars" was hosted by Dr. Robert Haberle at NASA Ames Research Center on November 30 and December 1, 1984. The workshop was the first major activity of the NASA/LPI Study Project entitled "Mars: The Evolution of its Climate and Atmosphere" (MECA). Abstracts were accepted and a program established for the workshop by the MECA Steering Committee chaired by Dr. Ronald Greeley of Arizona State University. In addition to an abstract volume distributed to the 83 participants at the workshop, an LPI Technical Report will also be produced by the LPI Publications Office for distribution in mid-1985. Summaries of the four major questions addressed by the workshop attendees were presented at the 1984 Fall American Geophysical Union (AGU) Meeting held in San Francisco December 3-7, 1984. The summaries of the sessions were presented at the AGU meeting by the following workshop session chairmen: Dr. Michael Carr; Dr. Bruce Jakowsky; Dr. James Pollack; and Dr. Heinrich Wanke.

H. PUBLICATIONS AND COMMUNICATIONS

During this report period, the following projects were completed:

1. The first supplement of Proceedings of the 15th Lunar and Planetary Science Conference was published November 15. The volume, published by the American Geophysical Union as a supplement to JGR-red, contains 29 papers and 364 pages. The role of the Publications Department in preparing the papers for publication includes the following tasks: coordinating the review process; copyediting all manuscripts to JGR specifications; planning and scheduling production in cooperation with AGU personnel; typesetting manuscripts (with LPI Production Services Dept.) on a contract basis with individual authors; marking galleys and shipping them to authors and back to AGU for correction. The Proceedings Editor is Dr. Graham Ryder of LPI, and the JGR-red Editor is Dr. Gerald Schubert of UCLA.

2. Abstract Volumes

- a. An abstract volume entitled Papers Presented to the Conference on the Origin of the Moon was published by the LPI Publications Department during September. The volume contains 48 abstracts and numbers 60 pages. The Conference was held in Kona, Hawaii on October 13-16, 1984. A post-conference volume entitled Origin of the Moon will be published by LPI during 1985; scientific editors for the book will be Drs. G. J. Taylor of University of New Mexico, R. J. Phillips of Southern Methodist University, and W. K. Hartmann of Planetary Science Institute.
- b. An abstract volume for the Workshop on Water on Mars was published for distribution at the workshop November 30-December 1. This 90-page volume contained 39 abstracts. Publication of a technical report from the workshop is planned for 1985.

3. Lunar and Planetary Institute Contributions

To document the activities of the visiting and staff scientists and other work supported by the Institute, this formal series called "Lunar and Planetary Institute Contributions" was initiated in September 1969 while the Institute was under the auspices of the National Academy of Sciences.

The following table shows a periodic listing of the contributions since implementation of the program:

PERIOD	CONTRIBUTIONS	LPI NUMBERS
Prior to 11 December 1969	1	1
11 December to 31 May 1971	68*	2-69
1 June 1971 to 30 June 1972	34	70-103
1 July 1972 to 30 June 1973	49	104-152
1 July 1973 to 30 June 1974	3	153-184
1 July 1974 to 30 June 1975	32	185-216
1 July 1975 to 30 June 1976	30	217-246
1 July 1976 to 30 June 1977	33	247-279
1 July 1977 to 30 June 1978	48	280-327
1 July 1978 to 30 June 1979	54	328-382
1 July 1979 to 30 June 1980	27	383-409
1 July 1980 to 30 June 1981	31	410-440
1 July 1981 to 30 June 1982	39	441-479
1 July 1982 to 30 June 1983	39	480-518
1 July 1983 to 30 June 1984	18	519-525
1 July 1984 to 31 Dec 1984	18	537-554

*Includes 28 contributed papers to LPI's Meteorite Impact and Volcanism Conference

During the current period, of the 18 papers numbered in the series through 31 December 1984 11 were authored or co-authored by staff scientists or other staff members, 5 were by visiting scientists, and 2 included both staff and visiting scientists. (See Appendix IV for list of LPI Contributions for the period July to December 1984).

4. Lunar and Planetary Information Bulletin

One issue of the Bulletin was published during this reporting period. The November issue (no.39) contained the announcement of the 16th Lunar and Planetary Science Conference, other topical conferences and meetings of interest to the community and the regular features of news items, new publications, calendar of events, and current awareness bibliography. Total circulation of the Bulletin now exceeds 4700.

I. PANELS, TEAMS, WORKING GROUPS, AND COMMITTEES

Lunar and Planetary Geoscience Review Panel (LPGRP)

The Chairman, Dr. G. J. Taylor, of the Lunar and Planetary Geoscience Review Panel (formerly the Lunar and Planetary Review Panel [LPRP] and the four Group Chiefs met at Caltech on August 23 and 24 to discuss review assignments for all proposals received thus far and to make assignments for proposals expected to be received by the September 1st deadline. Also discussed were the budget and plans for the October meeting in Houston. The full Panel met at the LPI from October 21 athrough October 25. The newly reconstituted Panel, divided into four groups -- Mineralogy and

Petrology, Geochemistry, Geophysics, and Planetary Surface Science -- reviewed and evaluated 191 proposals at this annual meeting.

Lunar and Planetary Sample Team (LAPST)

The Lunar and Planetary Sample Team, chaired by Dr. L. A. Taylor, met at the Lunar and Planetary Institute on November 16-18. At this meeting the team considered 21 requests for lunar samples and generated 10 memoranda to the Chief of the Solar System Exploration Division. They discussed the long-term agenda for LAPST, curatorial facilities, and lunar base materials. The team reconsidered the Lin request and proposal for lunar soil to be used in the preparation and testing of concrete for lunar base or space station construction.

Meteorite Working Group (MWG)

The Meteorite Working Group met in the Mineral Sciences Department of the National Museum of Natural History, Smithsonian Institution, D. C., on September 7-9. A special session devoted to a review of the accomplishments and directions of the MWG program was held Friday morning for members and a number of invited guests. The Group acted on 33 requests for samples. They also discussed sample transfer to the Smithsonian, consortia studies, and future commitments.

Mission Operations and Information Systems Subcommittee of the Solar System Exploration Committee (MOIS/SSEC)

The Mission Operations and Information Systems Subcommittee of the Solar System Exploration Committee met May 9-11 at the Jet Propulsion Laboratory, Pasadena. They are concerned with maintaining high quality science while reducing costs such as low to moderate cost planetary missions that are to be flown through the end of this century. The Group met again on August 28-31 at Boulder, Colorado, to prepare a final report.

Planetary Cartography Working Group (PCWG)

The Planetary Cartography Working Group (PCWG), chaired by Dr. Ronald Greeley, met in Reno, Nevada on November 5. This group discussed in detail their 1-year plan, the progress being made on planetary coordinates and reference surfaces, digital cartography, and "radar grammetry". The next meeting of the PCWG will be in Washington, D. C. on February 11-12.

Early Crustal Genesis Review Panel (ECGRP)

The Early Crustal Genesis Review Panel, chaired by Dr. Kevin Burke, met at the LPI on November 12-14 for the purpose of discussing and determining funding for the twenty-six proposals they received. They also discussed other aspects of the ECG Program.

Program Management Working Group (PMWG)

The Program Management Working Group, chaired by Dr. Don Bogard, NASA Discipline Scientist for Planetary Materials and Geochemistry, met in the Hess Room at the LPI on October 26-27. This Group will serve as a focal point for informing NASA Management of scientific highlights pertaining to the Planetary Materials and Geochemistry Program. The topic for discussion at this meeting was the broad and long-term issues and policies concerning the Program.

J. NASA-AMES VERTICAL GUN RANGE (AVGR)

The NASA-Ames Vertical Gun Range (AVGR) supported projects dealing with impact-induced spallation (application to the martian meteorite problem) and projectile shape effects (application to crater scaling) during the report period. Due to problems in procurement at Ames, primers for the light-gas gun were at a premium and some tests had to be delayed. During the report period the NASA-Ames contract monitor (Frank Centaloni) announced his retirement, and the LPI Science Coordinator (Peter Schultz) announced his acceptance of an academic position at Brown University. In order to provide continuity, Dr. Schultz agreed to continue his role as the LPI Science Coordinator at Brown through a visiting staff scientist appointment (unsalaried). This one-year arrangement was with concurrence of W. Quaide, J. Boyce, F. Centaloni, and K. Burke. During a visit to NASA-Ames in December, Dr. Schultz met with Frank Centaloni and his replacement, T. Polek, to review the AVGR status and matters related to photographic services. In addition, he met with other NASA-Ames personnel involved in revitalizing the overall ballistic range programs at Ames. As a result of these meetings and follow-up communications, some procedural changes were made in order to improve investigator support.

K. LUNAR AND PLANETARY SCIENCE COUNCIL

The Lunar and Planetary Science Council reports directly to the USRA Board of Trustees. It has been charged with the responsibility for advising the Board on all matters relating to USRA activities in lunar and planetary science. Accordingly, it is the principal USRA group reviewing, in association with the Director, the programs of the LPI and making recommendations to the Board on policy matters relating to technical or scientific programs at the Institute.

Council members during this report period were:

Dr. Klaus Keil (Convener), Institute of Meteoritics, University of New Mexico, Albuquerque.

Dr. Raymond E. Arvidson, Department of Earth and Planetary Sciences, Washington University, St. Louis.

Dr. Albert W. Bally, Department of Geology, Rice University, Houston.

Dr. Richard A. F. Grieve, Division of Gravity. Geotherm, Ottawa,
Ontario.

Dr. William M. Kaula, Department of Earth and Planetary Sciences,
University of California, Los Angeles and National Oceanic and
Atmospheric Administration's National Geodetic Survey Division..

Dr. Harry McSween, Department Geological Sciences, University of
Tennessee, Knoxville.

Dr. Gunter Lugmair, Chemistry Department, University of California,
San Diego.

Dr. Richard O'Connell, Department of Geological Sciences, Harvard
University, Cambridge.

Dr. Stanton J. Peale, Department of Physics, University of California,
Santa Barbara.

Dr. Laurence A. Soderblom, U. S. Geological Survey, Flagstaff.

ANTICIPATED EFFORT DURING NEXT REPORT PERIOD

1 January 1985 - 30 June 1985

AND BEYOND

Contract negotiations are now in progress with a view to establishment of a three year commitment from NASA, Jul. 85 - Jun. 88.

As implementation of the recommendations of the Solar System Exploration Committee (SSEC) of the NASA Advisory Council is being initiated, the Institute is playing a characteristic scientific role complementary to that of mission dedicated scientific programs. For example: A Mars geoscience orbiter figures among early planetary explorer class missions, and the Mars Data Analysis Program, for which the Institute is responsible, relates closely to the proposed mission. Scientists at the Institute are also well-equipped to respond to early development of a lunar science orbiter and to possible renewed lunar exploration. A workshop on lunar surface materials held in February 1984 represented an initial involvement in the scientific aspects of these developments and a major topical conference, held in October 1984, on the origin of the Moon constituted a more substantial effort.

These examples of planned scientific efforts by the staff in relation to Mars and the Moon emphasize both the breadth and the flexibility of the Institute's research efforts. The Institute can successfully fulfill its numerous service functions for NASA, such as running workshops and conferences, publishing books and organizing review panels, because the scientific staff are committed to and active in solar system research and thus are able to provide for NASA a body of scientific expertise in the research environment that gives the Institute its unique character.

The Institute has long provided a service for the SSEC, and to a lesser extent for other branches of NASA, in organizing peer review panels, working groups, and teams. Plans for the next three years involve some restructuring of the existing panel organization in response to organizational changes within the SSEC, but no radical change in proven procedures.

Innovations in the Institute within the next three years are anticipated that relate to the Director's involvement in global geology and in the history of the Earth as a planetary body. The early history of the Earth forms part of a major investigation in comparative planetology (Early Crustal Genesis Program) which is proving successful in bringing together scientists with varied approaches to a single important issue.

Both the NASA Advisory Council's Earth System Science Committee and the National Academy of Sciences Global Geology committee are presently

reviewing the best ways to address problems of global terrestrial geology. The Institute is outstandingly qualified in staff, facilities and in operational style to play an extremely important role in new developments as it has done in other innovative phases over the last 15 years.

Workshops, Meetings, and Conferences (as of this date) for 1985 are:

16th Lunar and Planetary Science Conference - 3/11-15/85

Workshop on the World's Oldest Rocks - 6/19-30/85

MECA Workshop on Evolution of the Martian Climate - 8/10-11/85

Conference on Heat and Detachment in Crustal Extension on Continents and Planets - 10/10-12/85

The Earth as a Planet (The First Annual LPI/GSA Planetary Workshop) - 10/27/85.

On October 27, the Lunar and Planetary Institute and the Planetary Geology Division of the Geological Society of America will co-sponsor "The Earth as a Planet", the first in a series of topical planetary workshops that will be held in association with the annual meeting of the GSA. This year's one-day workshop is planned for the Sunday preceding this year's annual meeting in Orlando.

Enthusiasm for the idea of looking at the Earth as a planet is widespread at this time (see, for example, Burton Edelson's editorial in Science, January 25, 1985) and Don Anderson and Kevin Burke have agreed to organize the workshop. Four sessions are planned on general themes: 1) Mega-geomorphology, 2) the mantle: the largest part of the Earth, 3) the Early Earth: a typical young planet? and, 4) new methods of remote sensing of the earth and planets.

For more information (conveners, locations, publications) on Workshops and Conferences, please see Summary Table in Appendix II, Part A.

APPENDIX I

PART A: SCIENTIFIC STAFF AND LONG-TERM VISITOR
APPOINTMENTS AND PUBLICATIONS

PART B: VISITOR ROSTER

PART C: STAFF AND VISITOR OFF-SITE SCIENTIFIC
ACTIVITIES

APPENDIX I*

SCIENTIFIC STAFF FY 1985

1 July 1984 - 31 December 1984

Ashwal, Lewis D. (Appointment: 3 September 1980 - 2 September 1985)
 Field: PETROLOGY/GEOCHEMISTRY - origin and evolution of planetary crusts and mantles; Precambrian geologic history; petrology, mineralogy, and geochemistry of anorthosite and related rocks; origin of magmatic ore deposits; role of volatiles in igneous and metamorphic processes; Rb-Sr and Sm-Nd isotope geochronology; fluid inclusion studies; meteorites as possible martian samples.

Publications*

- Ashwal, L. D. (with J. Longhi) 1984. Two-stage models for lunar and terrestrial anorthosites: Petrogenesis without a magma ocean. Proc. Lunar Planet. Sci. Conf. 15th, in press.
- Ashwal, L. D. (with R. L. Rudnick, D. J. Henry, E. K. Gibson, E. Roedder and H. E. Belkin) 1984. Fluid inclusions in stony meteorites--a cautionary note. Proc. Lunar Planet. Sci. Conf. 15th, in press.
- Ashwal, L. D. (with P. Morgan, S. A. Kelley and J. A. Percival) 1984. An Archean crustal radioactivity profile: The Kapuskasing Structural Zone, Ontario. Geol. Soc. Amer. Abstracts with Programs, v. 16, p. 433.
- Ashwal, L. D. (with R. L. Rudnick and D. L. Henry) 1984. Fluid inclusions in high-grade gneisses of the Kapuskasing Structural Zone, Ontario: Metamorphic fluids and uplift/erosion path. Contr. Mineral. Petrol., v. 87, pp. 399-406.
- Ashwal, L. D. (with J. L. Wooden) 1984. Sm-Nd isotopic studies of Proterozoic anorthosites: Systematics and implications. Proc. NATO Adv. Study Institute, "The Deep Proterozoic Crust in the North Atlantic Provinces, Norway, July, 1984, in press.
- Ashwal, L. D. (with D. A. Morrison, D. W. Davis, J. L. Wooden, D. D. Bogard, D. E. Maczuga, and W. C. Phinney) 1984. Age of the Mulcahy Lake intrusion, NW Ontario, and implications for the evolution of granite-greenstone terrains. Earth and Planetary Science Letters, in press.

*Appendix I lists only those publications that have appeared in print or were in progress during the report period and which were not included in the previous report.

Ashwal, L. D. (with D. A. Morrison, D. E. Maczuga, and W. C. Phinney) 1984.
Stratigraphy and petrology of the Mulcahy Lake layered gabbro: An
Archean intrusion in the Wabigoon Subprovince, Ontario.
Jour. Petrology, in review.

Ashwal, L. D. (with J. L. Wooden, W. C. Phinney and D. A. Morrison) 1985.
Sm-Nd and Rb-Sr isotope systematics of Archean anorthosites and
related rocks from the Superior Province of the Canadian shield.
Earth Planet. Sci. Letters, in review.

Bills, Bruce (Appointment: 13 February 1984 - 13 February 1987)
 Field: PLANETARY GEOPHYSICS - determination and interpretation of global scale planetary gravity and topography, with emphasis on tectonic processes and planetary rotational dynamics.

Publications

- Bills, B. G. (with M. Kobrick) 1984. Venus Topography: A Harmonic Analysis. J. Geophys. Res., 90, 827-836.
- Bills, B. G. (with W. S. Kiefer) 1984. A Harmonic Analysis of Venusian Gravity, EOS, 65, 981.
- Bills, B. G. (with W. Kiefer) 1984. Atla and Beta: Gravity Models of Venusian Volcanic Provinces. EOS, 65, 982.
- Bills, B. G. 1985. Climatic Variations on Venus, in preparation.
- Bills, B. G., 1985. Venus Rotation: Orbital Eccentricity Induced Variations in Tidal and Resonant Torque Balance, in preparation.

Burke, Kevin (Appointment: 1 September 1983-)

Field: GEOLOGY - research in plate tectonics to interpret geological history of the earth; research on operation of Wilson cycle of the opening and closing of oceans on earth, concentrating on Caribbean evolution over the last 200 my and early crust in the Archean.

Publications

Burke, K., 1984. Plate tectonic history of the Arctic in: ARCTIC GEOLOGY. Report of Colloquium, Vol. 4, p. 189, 27th International Geological Congress Moscow, Nauka, Moscow.

Burke, K. (with Paul Mann), 1984. Cenozoic rift formation in the northern Caribbean, Geology, v. 12, pp. 732-736.

Burke, K. (with P. Mann and T. Matumoto), 1984. Neotectonics of Hispaniola: plate motion, sedimentation, and seismicity at a restraining bend. Earth and Planetary Science Letters, 70, pp. 311-324.

Burke, K. (with P. Mann), 1984. Neotectonics of the Caribbean. Reviews of Geophysics and Space Physics, Vol. 22, No. 4, pp. 309-362.

Morgan, Paul (Appointment: 2 September 1980 - 12 August 1984)
 Field: GEOPHYSICS - heat flow and seismic studies in active tectonic environments, the genesis, structure and evolution of continental rifts, and geothermal systems.

Publications

- Morgan, P. (with I. B. Ramberg), 1984. Physical characteristics and evolutionary trends of continental rifts. Proceedings 27th International Geological Congress, vol. 7, VNU Science Press BV, Utrecht, pp. 165-216.
- Morgan, P., 1984. The thermal structure and thermal evolution of the continental lithosphere. Phys. Chem. Earth, vol. 15, pp. 107-193.
- Morgan, P. (with W. J. Hinze and L. W. Braile) 1984. Exploration for hot dry rock geothermal resources in the midcontinent USA. Los Alamos National Laboratory Report (3 volumes), in press.
- Morgan, P. (with M. P. Golombek) 1984. Two Phases and two styles of extension in the Northern Rio Grande rift. New Mexico Geological Society 35th Field Conference Guidebook, pp. 13-19.
- Morgan, P. (with P. H. Daggett and F. K. Boulos) 1984. Seismicity and active tectonics of the Egyptian Red Sea margin and the Northern Red Sea. Journal of Geophysical Research, in press.
- Morgan, P., 1984. Crustal radiogenic heat production and the selective survival of ancient continental crust. Proceedings 15th LPSC; Journal of Geophysical Research, in press.
- Morgan, P. (with C. A. Swanberg) 1984. Heat flow in the Colorado plateau and adjacent areas. Submitted to 1983 Hamburg IUGG "Plateau Uplift, Rifts and Volcanism" volume. Journal of Geodynamics, in press.
- Morgan, P. (with C. A. Swanberg) 1984. On the Cenozoic uplift and tectonic stability of the Colorado plateau. Submitted to 1983 Hamburg IUGG "Plateau Uplift, Rifts and Volcanism" Volume. Journal of Geodynamics, in press.

Ryder, Graham (Appointment: 3 November 1983--)
 Field: GEOLOGIST - igneous and metamorphic petrology, planetology.
 Petrographic, petrochemical, microprobe studies.

Publications

Ryder, G., 1984. Most olivine in the lunar highlands is of shallow origin
 (Abs.) Lunar Plan. Sci. XV, 707-708.

Ryder, G., 1984. Olivine in lunar dunite 72415, a rather shallow origin
 cumulate (Abs.) Lunar Plan. Sci. XV, 709-710.

Ryder, G. (with B. Spettel) 1984. Towards understanding lunar pristine
 rocks: pursuing petrogenesis in Stillwater Norite 1 (Abs.) Lunar
 Plan. Sci. XV, 711-712.

Ryder, G., 1984. Chemistry and origin of oikocrysts in the Stillwater
 (Abs.). Trans. Am. Geophys. Union, v. 65, p. 294-295.

Ryder, G., 1984. Minor elements in Marjalahti olivine. Meteoritics 19,
 79-83.

Ryder, G. (with B. Spettel) 1985. The Parental Magma for some rocks from
 the Norite 1 subzone of the Stillwater: A lunar analog study.
Proc. Lunar Planet. Sci. Conf. 15th, in press.

Ryder, G., 1984. Oxidation and layering in the Stillwater intrusion (Abs.)
Geol. Soc. Am. Abs. with Prog., v. 16, p. 642.

Schultz, Peter H. (Appointment: 1 September 1976 - 2 September 1984)
 Field: PLANETARY GEOLOGY - atmospheric effects on impact crater
 formation; emplacement mechanics of ejecta on the Moon and
 Mars; experimental impact cratering; structure and evolution of multi-ring
 impact basins; Martian polar wandering; computer-code simulation of impact
 cratering.

Publications

- Schultz, P. H. (with R. A. Arvidson, E. Levinthal and R. S. Saunders),
 1983. Remote sensing of the surfaces of terrestrial moons and
 planets. In Manual of Remote Sensing, vol. II, second edition,
 pp. 2385-2415.
- Schultz, P. H. (with T. Matsui), 1984. On the brittle-ductile behavior of
 iron meteorites: New experimental constraints. Proc. 15th Lunar and
 Planetary Science Conf., J. Geophys. Res., 89, C323-328.
- Schultz, P. H. (with D. E. Gault), 1984. Clustered impacts: Experiments
 and implications. J. Geophys. Res., Vol. 90, pp. 3701-3732.
- Schultz, P. H. (with A. B. Lutz), 1984. Polar wandering on Mars.
Scientific American (in press).
- Schultz, P. H. (with A. F. Chicarro and P. Masson) 1984. Global and
 regional ridge patterns on Mars. Icarus, in press.

LONG TERM VISITORS, THEIR APPOINTMENTS AND PUBLICATIONS DURING
THIS REPORT PERIOD

Clifford, Stephen M., Visiting Post-Doctoral Fellow (Appointment: 31
January - 1984 - 31 January 1985).
Field: PLANETARY VOLATILES/GEOLOGY: physics of H₂O and solute
transport in cold planetary regoliths.

Publications

- Clifford, S. M., 1984. Do the martian polar caps have equilibrium
profiles? EOS: Trans., Amer. Geophys. Union 65, p. 979.
- Clifford, S. M., 1984. Mars: Groundwater mound development in response to
polar basal melting. Abstracts presented to the Workshop: Water on
Mars, pp. 9-11, LPI Houston.
- Clifford, S. M., 1984. Mars: Permeability requirements for a global
groundwater system driven by polar basal melting. Abstracts Presented
to the Workshop: Water on Mars, pp. 12-14, LPI Houston.
- Clifford, S. M. (with D. Hillel), 1983. Knudsen diffusion: Gaseous
transport in small soil pores, submitted to Soil Science.
- Clifford, S. M., 1984. Polar basal melting on Mars. Submitted to
J. Geophys. Res.
- Clifford, S. M. (with M. L. Allison), 1984. Ice-covered water volcanism on
Ganymede. Submitted to J. Geophys. Res.
- Clifford, S. M. (with F. P. Fanale), 1985. The thermal conductivity of the
martian crust. Lunar and Planetary Science Conference XVI, in press.
- Clifford, S. M. (with P. H. Schultz and J. Simon), 1985. Ice-bedded
unconformable deposits as a possible source for outflow/run-off
channels. Lunar and Planetary Science Conference XVI, in press.

Francis, Peter, Visiting Senior Scientist (Appointment: 16 February 1981 - 16 February 1986)
Field: GEOLOGY - early crustal genesis on terrestrial planets.

Publications

- Francis, P. W. (with R. S. Thorpe and L. J. O'Callaghan), 1984. Relative roles of source composition, fractional crystallization and crustal contamination in the petrogenesis of Andean volcanic rocks (Abs.). Phil. Trans. Roy. Soc. Lond., A. 310, 675-692.
- Francis, P. W. (with R. S. J. Sparks, L. J. O'Callaghan and R. S. Thorpe), 1984. Ignimbrites of the Cerro Galan Caldera, N. W. Argentina. J. Volcanol. Geotherm. Res., in press.
- Francis, P. W., 1984. The origin of the 1883 Krakatau tsunamis. J. Volcanol. Geotherm. Res., in press.
- Francis, P. W., 1984. The Socompa volcano, north Chile and its avalanche deposits. Geology, in press.
- Francis, P. W. (with D. A. Rothery), 1984. A remote sensing study of a sector collapse volcano (Socompa, North Chile). In Proc. 18th Int. Symp. on Remote Sensing of Environment, Paris, France, Oct. 1984.
- Francis, P. W., 1984. The Origin of the Krakatau Tsunamis. J. Volcanol. Geotherm. Res., in press.
- Francis, P. W. (with R. S. Sparks, L. J. O'Callaghan, and R. S. Thorpe), 1984. Ignimbrites of the Cerro Galan caldera. J. Volcanol. Geotherm. Res., in press.
- Francis, P. W. (with L. J. O'Callaghan), 1984. Physical and chemical evolution of the San Pedro volcano, El Loa Province, North Chile. J. Geol. Soc., London, in press.
- Francis, P. W. (with M. Gardeweg, L. J. O'Callaghan, C. F. Ramirez, and D. A. Rothery), 1984. Catastrophic debris avalanche deposit of Socompa volcano, North Chile, Geology, in press.
- Francis, P. W., 1984. Venus and the VRM Mission, Geology Today, in press.

Gust, David A., Visiting Post-Doctoral Fellow (appointment: 8 March 1984 - 8 March 1985.

Field: GEOLOGY/Experimental Petrology and Geochemistry

Publications

Gust, D. A. (with R. J. Arculus, J. B. Dawson, R. H. Mitchell, and R. D. Holmes), 1984. Oxidation States of the Upper Mantle Recorded by Megacryst Ilmenite in Kimberlite and Type A and B Spinel Lherzolites, Contrib. Mineral Petrol. 85, pp. 85-94.

Gust, D. A. (with R. J. Arculus, R. J. Moore, E. W. Wolfe, and G. E. Ulrich), 1984. Mantle-derived Magma Interaction with Crust and the Development of Hybrid Alkalic-Calcalic Lineages, Geol. Soc. Am. Abstracts 16, pp. 526.

Gust, D. A. (with R. J. Arculus, J. Ferguson, B. W. Chappell, D. Smith, M. T. McCulloch, I. Jackson, H. D. Hensel, S. R. Taylor, and J. Knutson), 1984. Eclogites and Granulites in the Lower Continental Crust: Examples from Eastern Australia and Southwestern U. S. A.: in Eclogite and Eclogite-facies Rocks, Developments in Petrology (D. C. Smith, ed.), Chapter 6, in press.

Gust, D. A. (with M. A. Uliana, K. T. Biddle, and D. W. Phelps), 1984. Significado del Volcanismo y Extension Mesojurasicos en el Extremo Meridional de SudAmerica: Revista Argentina, in press.

Gust, D. A. (with K. T. Biddle, D. W. Phelps, and M. A. Uliana), 1984. Associated Middle-to-Late Jurassic Volcanism and Extension in Southern South America, Tectonophys., in press.

Gust, D. A. (with R. J. Arculus), 1984. Petrogenesis of Alkalic and Calc-Alkalic rocks of Mormon Mountain Volcanic Field, Arizona. Submitted to Contrib. Mineral Petrol.

Zimbelman, James R. - Visiting Post-Doctoral Fellow (Appointment: 5 November 1984 - 5 November 1985)

Field: PLANETARY GEOLOGY - Analysis of high resolution thermal infrared and photographic data from the equatorial region of Mars.

Publications

Zimbelman, J. R. (with R. Greeley), 1984. Topographic effects on the visual reflectance values of Ascraeus Mons, Mars.
Bull. Am. Astron. Soc., 16, p. 681.

Zimbelman, J. R., 1984. Photogeology of Ascraeus Mons, Mars: Elevation-dependent depositional record. Geol. Soc. Am. Abs. Prog., 16, p. 705.

Zimbelman, J. R. (with R. Greeley), 1984. Geologic interpretation of remote sensing data for the martian volcano Ascraeus Mons. Reports of the Planetary Geology Program, NASA TM (in press).

Zimbelman, J. R. (with J. Fink), 1984. Field measurements of the 1983 Royal Gardens lava flows, Kilauea volcano, and 1984 Mauna Loa lava flow, Hawaii. Reports of the Planetary Geology Program, NASA TM (in press).

Zimbelman, J. R., 1984. Geologic interpretation of remote sensing data for the martian volcano Ascraeus Mons. (Accepted for publication in Advances in Planetary Geology, NASA TM).

Zimbelman, J. R., 1984. Estimates of rheologic properties for flows on the martian volcano Ascraeus Mons. (In preparation.)

LUNAR AND PLANETARY INSTITUTE
DOMESTIC VISITING SCIENTIST (VS)
July 1, 1984 — December 31, 1984

NAME	APPT. PERIOD	IN RESIDENCE (this period)		PURPOSE OF VISIT	AFFILIATION
		DATES	NO. WKS.		
Basu, A.	06/25/84- 07/08/84	07/01/84-	1.14	To complete a study on the analysis of agglutinitic glass.	Indiana University, Bloomington
		07/08/84			
Nier, A.	10/31/84- 11/02/84	10/31/84-	.43	To review the progress of the Mass Spectrometry-Isotope Dilution experiment being developed for <u>in situ</u> analysis of cometary dust.	University of Minnesota, Minneapolis
		11/02/84			
Pepin, R.	03/06/82- 03/31/85	-0-	-0-	To continue research on the origin and history of the early solar system and to participate in projects related to his field of expertise.	University of Minnesota Minneapolis
Schultz, P.	09/03/84- 09/03/85	-0-	-0-	To continue to serve as science coordinator for the NASA Ames Vertical Gun and to continue with present research activities.	Brown University, Providence
Smith, R.	08/04/84- 08/08/84	-0-	-0-	To make use of the LPI VAX 11/780 computer and software for finite-element modeling.	University of Utah, Salt Lake City
Strnka, L.	10/01/79- 11/15/86	-0-	-0-	To continue research on the origins of planetary magnetism.	EXXON Production Research Co., Houston
Wendlandt, R.	10/09/82- 10/09/84	-0-	-0-	To continue research in the Effects of Volatiles of Magmatic Processes and Planetary Evolution: F, Cl, CH ₄ , and S.	EXXON Production Research Co., Houston

LUNAR AND PLANETARY INSTITUTE
FOREIGN VISITING SCIENTISTS (FVS)
July 1, 1984 — December 31, 1984

NAME	APPT. PERIOD	IN RESIDENCE (this period)		PURPOSE OF VISIT	AFFILIATION
		DATES	NO. WKS.		
Francis, P.	01/06/83- 02/17/86	12/28/84- 12/31/84	.57	To conduct LPI related research in planetary and regional geology, and provide leadership and play a key role in the organization and execution of the science project concerning Early Crustal Genesis on the Terrestrial Planets. Also, to make significant use of the Image Processing Facility.	The Open University England

LUNAR AND PLANETARY INSTITUTE
VISITING POST-DOCTORAL FELLOWS (VPDF)
July 1, 1984 — December 31, 1984

NAME	APPT. PERIOD	IN RESIDENCE (this period)		PURPOSE OF VISIT	
		DATES	NO. WKS.		
Clifford, S.	01/31/84- 02/01/85	07/01/84- 12/31/84	26.29	The primary purpose is to work in planetary volatiles.	LPI (formerly Univ. Massachusetts, Amherst)
Gust, D.	03/08/84- 03/08/85	07/01/84- 12/31/84	26.29	To conduct research centered around mantle petrology, utilizing experimental techniques to study mineral stabilities and partition coefficients.	LPI (formerly JSC/NRC Fellow)
Zimbelman, J.	11/05/84 11/05/85	11/05/84- 12/31/84	8.14	To produce images and plotted maps of the best resolution thermal data in the sixteen equatorial quadrangles of Mars.	LPI (formerly Arizona State University, Tempe)

LUNAR AND PLANETARY INSTITUTE
VISITING GRADUATE FELLOWS (VGF)
July 1, 1984 — December 31, 1984

NAME	APPT. PERIOD	IN RESIDENCE (this period)		PURPOSE OF VISIT	AFFILIATION
		DATES	NO. WKS.		
Agosto, W.	03/12/84-	07/01/84-	21.71	To conduct research on the extraction and processing of lunar and asteroidal meetings.	University of Houston, Central Campus
	09/12/84	09/12/84			
	10/15/84-	10/15/84-			
	10/15/85	12/31/84			
Brown, C.	10/10/83-	-0-	-0-	To work with R. Phillips/LPI on the North African Lithosphere Project using the LPI Image Processing Facility.	Southern Methodist Univ., Dallas
	10/10/84				
Eddington, P.	08/04/84-	08/04/84-	.57	To make use of the LPI VAX 11/780 computer and software for finite-element modeling.	University of Utah, Salt Lake City
	08/08/84	08/07/84			
Kohring, C.	09/01/84-	-0-	-0-	To develop an interactive image processing and pattern classification program.	Rice University, Houston
	09/01/85				
Lifftman, K.	05/15/84-	07/01/84-	6.57	To work with D. Heyman/Rice University and D. Bogard/JSC on isotopic anomalies in carbonaceous chondrites.	University of Houston, Central Campus
	08/15/84	08/15/84			
Marriott, K.	06/14/84-	07/01/84-	5.86	Primary purpose of visit will be digitizing and data reduction of impact experiments and surface process studies under guidance of P. Schultz/LPI.	University of Manitoba, Canada
	08/10/84	08/10/84			
Russell, J.	03/01/84-	07/01/84-	6.57	To continue research on experimental and petrographic study of two lava flows from the Taos Plateau, under the direction of G. Lofgren/JSC.	California Institute of Technology, Pasadena
	08/15/84	08/15/84			
Silver, L.	10/24/83-	-0-	-0-	To study the role of water in silicate magmas — a Ph. D. Thesis research project under the guidance of E. Stolper/Cal Tech.	University of Massachusetts, Amherst
	03/31/84				
	05/01/84-	-0-			
	09/30/84				
Stam, M.	06/26/84-	07/01/84-	2.43	To add some final touches to thesis on martian impact basins that require the use of a digitizer and high resolution Viking Orbiter images.	
	07/17/84	07/17/84			

LUNAR AND PLANETARY INSTITUTE
VISITING UNDERGRADUATE FELLOWS (VUF)
July 1, 1984 — December 31, 1984

NAME	APPT. PERIOD	IN RESIDENCE (this period)		PURPOSE OF VISIT	AFFILIATION
		DATES	NO. WKS.		
Smrekar, S.	10/22/84- 02/22/85	10/22/84- 12/31/84	10.14	To continue project begun in summer as an Undergraduate Intern, in particular experimental investigation of the effects of impact on cold H O ice with F. Horz and M. Cintala/JSC.	Brown University, Providence

LUNAR AND PLANETARY INSTITUTE
VISITING UNDERGRADUATE INTERNS (VUI)
July 1, 1984 — December 31, 1984

NAME	APPT. PERIOD	IN RESIDENCE (this period)		PROJECT & ADVISOR	AFFILIATION
		DATES	NO. WKS.		
Bertka, C.	06/11/84- 08/17/84	07/01/84- 08/17/84	6.86	To clarify crystallization mechanisms in terrestrial and lunar basic plutonic systems. (G. Ryder/LPI)	University of Cincinnati, Ohio
Block, L.	06/11/84- 08/17/84	07/01/84- 08/17/84	6.86	The construction and testing of Geophysical models to test the hypothesis that Venus is a planet without plate tectonics. (P. Morgan/LPI)	Texas A & M University, College Station
Bollinger, J.	06/11/84- 08/17/84	07/01/84- 08/17/84	6.86	To compile orbital, chemical, and physical observations in order to address fundamental questions concerning how comets may be related. (C. Wood/JSC)	Cornell University, Ithaca
Bonner, R.	06/11/84- 08/17/84	07/01/84- 08/17/84	6.86	To work in geodynamics to review the tectonic evolution of hinge zones - more places where subducta zones and boundaries join. (K. Burke/LPI)	State University of New York; Albany
Fuller, J.	06/11/84- 08/17/84	07/01/84- 08/17/84	6.86	To analyse some of the lunar spectra on hand, using existing LPI computer programs, and assist in interpreting the results. (A. Potter/JSC)	University of Washington, Seattle

LUNAR AND PLANETARY INSTITUTE
VISITING UNDERGRADUATE INTERNS (VUI)
July 1, 1984 — December 31, 1984

NAME	APPT. PERIOD	IN RESIDENCE (this period)		PROJECT & ADVISOR	AFFILIATION
		DATES	NO. WKS.		
Haber, S.	06/11/84- 08/17/84	07/01/84- 08/17/84	6.86	To determine regional differences in drainage densities not only due to changes in lithology but also due to subsequent geologic processes. (P. Schultz/LPI)	Hofstra University, Hemstead, N. Y.
Johnson, P.	06/01/84- 08/17/84	07/01/84- 08/24/84	7.86	To construct a detailed numerical model for the development and subsequent evolution of a duricrust layer on Mars. (S.Clifford/LPI)	Duke University, Durham, N.C.
Kiefer, W.	06/11/84- 08/17/84	07/01/84- 08/17/84	6.86	To use Pioneer Venus Orbiter tracking data to derive a high resolution spherical harmonic model of the gravitational potential of Venus for use in compensation.	Texas Christian University, Fort Worth
Marks, G.	06/11/84- 08/17/84	07/01/84- 08/17/84	6.86	Samples will be searched for both primary and secondary fluid inclusions. Heating and cooling experiments will be carried out on selected samples in order to determine homogenization and freezing temperatures. (E. Gibson/JSC)	Ohio State University, Columbus
McDowell, A.	06/11/84- 08/17/84	07/01/84- 08/17/84	6.86	Development of a semi-empirical production model for spallogenic noble gases in chondritic meteorites. (L. Nyquist/JSC)	Rice University, Houston
Olds, S.	06/11/84- 08/17/84	07/01/84- 08/17/84	6.86	Support and conduct impact experiments with the vertical gun in order to address the differential comminution of planetary regoliths via suitable terrestrial analogs. (F. Horz/JSC)	University of Colorado, Boulder
Rhudy, L.	06/11/84- 08/24/84	07/01/84- 08/24/84	7.86	Fluid inclusions in proterozoic charnockites including microthermometry of fluid inclusions in granitic rocks associated with Labrador anorthosites. (L.Ashwal/LPI & W. Phinney/JSC)	University of Texas, Austin

LUNAR AND PLANETARY INSTITUTE
VISITING UNDERGRADUATE INTERNS (VUI)
July 1, 1984 — December 31, 1984

NAME	APPT. PERIOD	IN RESIDENCE (this period)		PROJECT & ADVISOR	AFFILIATION
		DATES	NO. WKS.		
Smrekar, S.	06/11/84- 08/17/84	07/01/84- 08/24/84	7.86	The execution of a series of laboratory impacts into target rocks at various low temperatures in an effort to understand the differences between the hot and cold cases. (M. Cintala/JSC)	Brown University, Providence
Young, C.	06/11/84- 08/17/84	07/01/84- 08/17/84	6.86	Experimental study of the diopside-jadeite system at intermediate and high pressures. Experiments analyzed by optical, XRD and electron microprobe methods. (D. Gust/LPI)	University of Washington, Seattle

APPENDIX I - PART C

STAFF & VISITOR OFF-SITE SCIENTIFIC ACTIVITIES

1 July 1984 - 31 December 1984

Dr. Kevin Burke spent July 11-17 in Trinidad conducting geodynamic field studies and looking at geophysical data as part of a program to investigate the way in which 2000 kilometers of motion of the Caribbean plate, with respect to South America in the last 40 million years, has been accommodated. (These studies were funded by the Geodynamic Program.)

Dr. Graham Ryder conducted field work on Mulcahy Lake Intrusion near Dryden (Ontario) Canada, July 23 - 29, and attended the Meteoritical Society Annual meeting, July 30 - August 2, and the Program Committee meeting for the Conference on the Origin of the Moon, August 3-4, Albuquerque, New Mexico.

Mr. Kin Leung attended the Eleventh ACM SIG-GRAPH and Gould/DeAnza User Group meetings in Minneapolis, Minn. July 24-27.

Ms. Pam Jones assisted with logistics at the Workshop on Cosmogenic Nuclides, July 26-27, Los Alamos, N. M.; provided organizational and logistical support for the 47th Meteoritical Society Meeting, July 30-August 3; attended the Program Committee meeting for the Conference on the Origin of the Moon, August 3-4, Albuquerque, N. M.

Dr. Kevin Burke attended the USRA/LPI Lunar and Planetary Science Council meeting on July 29 and the Meteoritical Society Meeting on July 30 in Albuquerque, N. M.

Ms. Jane Fuller, LPI Summer Intern, visited the McDonald Observatory, University of Texas, Austin, to use their spectrometer to obtain data for use in her summer research project, July 30-August 5. Ms. Fuller's visit was under the guidance of her project advisor, Dr. Andrew Potter from JSC.

Dr. Peter Schultz attended a workshop on Space Station Experiments in Planetary Geology at USGS in Flagstaff, Arizona, August 5-7.

Dr. Paul Morgan visited the AMOCO Production Company (International), Houston, to give a seminar on "Subsurface Temperatures in Rift Environments" on August 6. (This visit was at no cost to the LPI).

Members of the Computer Center, Mr. Leung, Ms. McAllister, Mr. Fessler, Mr. Jones, and Ms. Lyon, attended the 2nd Annual Houston Local DECUS Symposium on August 16 and 17.

Ms. Pam Jones visited Godthaab, Greenland on August 26 (with plans to return September 7) to arrange the logistics for the Early Crustal Genesis related workshop on the "World's Oldest Rocks".

Dr. Lew Ashwal spent September 5 at the Geology Department of the University of Houston (Main Campus) using their rock crushing equipment.

Ms. Lila Mager and Ms. Carla Owen provided logistical support for the Meteorite Working Group meeting in Washington, D. C. on September 7-9.

Ms. Olene Edwards and Ms. Sheila Bowles attended a NASA sponsored training seminar on the IBM PC DOS System and the Lotus 1-2-3 at the Beta Building, Clear Lake City, on September 10 and 11 -- Ms. Edwards in the morning and Ms. Bowles in the afternoon. (The seminar was timely since the Accounting Department only recently acquired IBM PC equipment which makes the USRA and the LPI Accounting Departments compatible.)

Ms. Pam Thompson and Mr. Carl Grossman attended a training seminar on the use of the EPICS photocomposition system at AM Varsity in Houston, September 10 through 14. The training is related to the recent upgrades to the equipment in the typesetting office.

Mr. Kin Leung, Ms Jackie Lyon, Ms. Olene Edwards, and Ms. Sheila Bowles attended a NASA sponsored advanced Lotus (spreadsheet) class on the IBM PC in the Beta Building in Clear Lake City on September 20.

Dr. Lew Ashwal presented a lecture on September 27 at the Rice University, Department of Space Physics and Astronomy, entitled "Meteorites from Mars".

Dr. Kevin Burke presented a talk at the University of Wyoming in Laramie entitled "Tectonics of China" and conducted Early Crustal Reconnaissance of Wyoming, October 3-6. (Portion of trip paid for by U. Wyoming.)

Dr. Kevin Burke attended a portion of the Division for Planetary Sciences meeting, the LPI Co-sponsored Conference on the Origin of the Moon, and a meeting of the Planetary Meetings Steering Committee in Kona, Hawaii, during the period October 11-16.

Ms. Pam Jones provided administrative and logistic support for the Origin of the Moon Conference and attended a meeting of the Planetary Meetings Steering Committee in Kona, Hawaii, during the period October 12-17.

Ms. LeBecca Turner provided logistical and clerical support for the Origin of the Moon Conference in Kona, Hawaii, during the period October 12-17.

Dr. Graham Ryder (Program Committee Member) attended the Conference on the Origin of the Moon in Kona, Hawaii, October 13-16.

Ms. Rebecca McAllister and Mr. Brian Fessler attended the AIAA Non von Neumann Computers Workshop at the Nassau Bay Hilton, October 16 and 17.

Ms. Pam Jones administered logistics for the Lunar Bases and Space Activities of the 21st Century Symposium in Washington, D. C. on October 28-31.

Dr. Kevin Burke attended the Geopotential Research Mission meeting at the University of Maryland in College Park, a portion of the Symposium on Lunar Bases in Washington, D. C., the COCORP meeting at Cornell in Ithaca, and gave a lecture at the Louisiana State University in Baton Rouge entitled "Tectonics of China" during the period October 28 - November 1. (Portions of this trip were funded by other sources.)

Dr. Lew Ashwal attended and presented a paper at the Geological Society of America meeting in Reno, Nevada, November 4-9. The title of his paper was "An Archean Crustal Radioactivity Profile: The Kapuskasing Structural Zone, Ontario".

Dr. David Gust attended and presented a paper at the Geological Society of America meeting in Reno, Nevada, November 4-9. The title of his paper was "Mantle-Derived Magma Interaction with Crust and the Development of Hybrid Alkalic-Calcalic Lineages". Dr. Gust participated in a post-meeting field trip on a convergent margin.

Dr. Stephen Clifford, in his role as Project Scientist, attended a MECA (Mars: The Evolution of its Climate and Atmosphere) Steering Committee meeting at the GSA meeting in Reno, Nevada, November 5.

Dr. Kevin Burke attended the Geological Society meeting and MECA Steering Committee meeting in Reno, Nevada, November 4-8.

Ms. Tracy McCasey and Ms. Renee Dotson attended a one-day seminar on "Working with People" held in Houston, November 13.

Dr. Kevin Burke spent the period November 26-30 at SUNY in Albany New York working with graduate students on problems of the geodynamic history of the Earth (funded through the Geodynamics Program of NASA).

Ms. LeBecca Turner provided logistics support November 29-December 2 for the LPI MECA "Water on Mars" Workshop held at the Ames Research Center, Moffett Field, California.

Dr. Bruce Bills attended the LPI MECA "Water on Mars" Workshop, Ames Research Center, Moffett Field, California, November 30-December 1.

Dr. David Gust presented a seminar on November 30 at the Department of Geology, University of Houston, entitled "Primary Island Arc Basalts: Their Nature and Evolution".

Mr. Kin Leung attended the Data Systems Users Working Group (DSUWG) meeting at Stanford University, Palo Alto, California, Nov. 30 and Dec. 1.

Dr. Stephen Clifford attended a meeting of the MECA Steering Committee at NASA Ames (Moffett Field, CA.) on December 1; presented a talk entitled "Mars: Permeability Requirements for a Global Groundwater System Driven by Polar Basal Melting" at the LPI/MECA Water on Mars Workshop held at NASA Ames, November 31 and December 1; and presented a talk entitled "Do the

"Martian Permanent Polar Caps have Equilibrium Profiles?" at the AGU meeting in San Francisco on December 3rd.

Dr. Kevin Burke attended the AGU meeting where, with Ron Greeley of ASU, he chaired an all-day session on Water on Mars and the USRA Lunar and Planetary Science Council meeting in San Francisco, and a MECA Steering Committee meeting at Ames during the period December 1-6. He also attended an ESSC Solid Earth Geophysics Working Group meeting in Monterey Bay, December 7-11. (The ESSC meeting was funded by other sources.)

Ms. Pam Jones attended a MECA Steering Committee meeting at Ames Research Center, Moffett Field, CA., on December 1.

Dr. Graham Ryder discussed LPSC Proceedings with AGU representatives (in conjunction with his role as Proceedings Editor) in San Francisco, December 3 and 4.

Ms. Karen Hrametz, LPI Managing Editor, met with AGU representatives, PMSC (Planetary Meetings Steering Committee) representatives, and editors in San Francisco on December 3 and 4 to discuss the LPSC Proceedings.

Dr. Bruce Bills attended the AGU meeting in San Francisco, December 3-6. He worked with W. L. Sjogren on Venus Gravity research at JPL in Pasadena, December 8-12.

APPENDIX II

PART A: PROJECTS, CONFERENCES, AND
WORKSHOPS

PART B: SEMINARS

APPENDIX II

Lunar and Planetary Institute Workshops and Conferences March 1982—October 1985

Topic	Dates	Conveners	Attendance-Sponsor	Publication
13th Lunar and Planetary Science Conference	3/15-19/82	M. Duke R. Phillips	557—LPI/JSC hosted by JSC	Abstract Volume Proceedings Volumes
Workshop on Antarctic Glaciology and Meteoritics	4/19-21/82	M. Lipschutz C. Bull	39—LPI	Abs.—LPI Tech. Rpt.
Workshop on Planetary Tectonics	4/19-21/82	R. Phillips	12—LPI in Burnet, TX.	
45th Annual Meeting of the Meteoritical Society	9/13-16/82	R. Walker G. Crozaz	210—LPI, Washington U, McDonnell Ctr. for the Space Sci.	Abstract Volume
Conference on Planetary Volatiles	10/9-12/82	R. Pepin R. O'Connell	100—LPI Arrowwood Conference Ctr. Alexandria, MN	Abstract Volume LPI Technical Report
Workshop on Pristine Lunar Highlands Rocks and the Early History of the Moon	10/15-17/82	J. Longhi G. Ryder	41—LPI Travelodge New Orleans	Abstracts LPI Technical Report
Conference on Chondrules and their Origins	11/15-18/82	E. King	64—LPI	Abstract Volume Proceedings Volume
14th Lunar and Planetary Science Conference	3/14-18/83	M. Duke R. Phillips	525—LPI/AGU/ JSC -hosted by JSC	Abstract Volume Proceedings Volume
1983 Archean Geochemistry — Early Crustal Genesis Field Workshop	8/10-16/83	L. Ashwal K. Card	46—LPI/Geol. Survey of Canada	Abstracts, Field Guide LPI Technical Report
Workshop on Past and Present Solar Radiation: Record in Meteoritic and Lunar Regolith Material	9/3-4/83	D. McKay R. Pepin	60—LPI at Max-Planck-Inst. in Mainz, F.R.G.	Abstracts Volume Technical Report
46th Annual Meeting of the Meteoritical Society	9/5-9/83	F. Begeemann H. Wanke	300—LPI, Max Planck Inst., in Mainz, F.R.G.	
Annual Meeting of the Association of Earth Science Editors	10/9-12/83	R. Ridings R. Merrill	93—LPI/AESE hosted by LPI w/sessions at Nassau Bay Hilton Houston, TX.	
Workshop on Lunar Surface Materials	2/14-15/84	G. Heiken L. Taylor	15—LPI	Book
15th Lunar and Planetary Science Conference	3/12-16/84	M. Duke K. Burke	550—LPI/JSC/ AGU/DPS/Met. Soc. hosted by JSC	Abstract Volume Proceedings Volume
Workshop on Early Earth: The Interval from Accretion to the Older Archean	4/23-25/84	K. Burke	80—LPI	Abstract Volume Technical Report
Workshop on Cosmogenic Nuclides	7/26-27/84	R. Reedy	40—LPI	Technical Report
47th Annual Meteoritical Society Meeting	7/30-8/2/84	K. Keil	296—LPI, Inst. Meteoritics & Dept. Geology at Univ. NM	Abstract Volume
Conference on the Origin of the Moon	10/13-16/84	W. Hartmann R. Phillips J. Taylor	105—LPI & DPS Kona, Hawaii	Abstract Volume Proceedings Volume
Conference on Water on Mars	11/30-12/1/84	R. Greeley R. Haberle	83—LPI & NASA Ames	Abstract Volume Technical Report
16th Lunar and Planetary Science Conference	3/11-15/85	K. Burke M. Duke	~500—LPI	Abstract Volume Proceedings Volume
Workshop on the World's Oldest Rocks	6/19-30/85	L. Ashwal V. McGregor	~30—LPI Godthaab, Greenland	Abstract Volume Technical Report
Workshop on Evolution of the Martian Climate	8/10-11/85	M. Carr C. Leovy R. Pepin	~40—LPI	Abstract Volume Technical Report
Conference on Heat and Detachment in Crustal Extension on Continents and Planets	10/10-12/85	I. Lucchitta P. Morgan L. Soderblom	~75—LPI & USGS	Abstract Volume Proceedings in Tectonophysics

APPENDIX II - PART B

SEMINAR SERIES

1 July 1984 - 31 December 1984

<u>DATE</u>	<u>SPEAKER(S)</u>	<u>TOPIC</u>
July 6	Dr. Alan Binder NRC Sr. Fellow/JSC	"Mare Basalt Petrogenesis"
July 20	Dr. Mike Zolensky NRC/JSC	"Identification of Fine-Grained Phases in Carbonaceous Chondrites"
August 10	Dr. John D. Clemens Ariz. State Univ.	"The Petrology of an Unexposed Lower Crustal Terrain"
August 17	Dr. Arch Reid Univ. of Capetown	"Basalts of the Southern Oceans"
September 7	Dr. Stephen Moorbath Oxford University	"Dating the Oldest Terrestrial Rocks: Fact and Fiction"
September 12	Dr. James E. McCoy NASA/JSC	"Electrodynamic Tethers"
October 1	Dr. Peter Denning/Res.Inst. Adv. Computer Sci.(RIACS)	"Visions of Scientific Computing Around 1995"
October 12	Dr. Bruce Bills LPI	"Venus: Gravity and Rotation"
October 19	Mr. Robert Richmond NASA/JSC	"Space Radiation and the Shuttle"
November 1	Dr. Alfred Nier U. Minnesota	"Fifty Years of Mass Spectrometry Applied to Geophysical and Geo- chemical Research"
November 15	Dr. Cyrena Goodrich U. New Mexico	"The Role of Carbon in Ureilite Petrogenesis"
November 30	Dr. Pam Kempton NRC/JSC	"Patent and Cryptic Metasomatism in Mantle Xenoliths: Causes and Implications"

APPENDIX II - PART B (continued)

SEMINAR SERIES

1 July 1984 - 31 December 1984

<u>DATE</u>	<u>SPEAKER(S)</u>	<u>TOPIC</u>
December 7	Dr. Tom Morgan Southwestern Univ.	"Filling in of Fraunhofer Lines in the Spectrum of the Moon and Mercury"
December 20	Dr. Stephen Barnes NRC/JSC	"Chromite Seams in Layered Intrusions: Experimental Data and Genetic Models"

APPENDIX III
OTHER MEETINGS AND ACTIVITIES
(held at LPI)

APPENDIX III

OTHER SCIENCE RELATED MEETINGS AND ACTIVITIES HELD AT LPI

1 July 1984 - 31 December 1984

Brown-Bag Seminars involving the LPI Summer Interns were held on July 6, 13, 20, and 27 at the LPI.

The JSC conducted an Astronaut Candidate Orientation on July 9-11 at the LPI.

The JSC Astronomical Society held meetings at the LPI on July 13; August 17; October 20; December 6 and 19.

The JSC Institutional Data Systems Division of the Mission Support Directorate held a retreat at the LPI on July 17.

Mrs. McAllister and Mrs. Mary Ann Hager served as hosts for the Remote Sensing Class from the University of Houston/Clear Lake on July 23rd. Mrs. McAllister gave a demonstration of the Image Processing Facility and Mrs. Hager gave a tour of the Planetary Image Center.

The JSC Space and Life Sciences Division held a Peer Review meeting at the LPI on August 2-4.

Brown-Bag Seminars involving the LPI Summer Interns and their Advisors were held at LPI on August 3, 10, and 17. Channel 11 News (Houston) filmed several Interns conducting their work and/or giving presentations on August 10 at LPI and at JSC; a short program was aired at 5pm (local time) that same evening.

Members of the JSC and NASA Headquarters Personnel Offices held a Personnel/Payroll Systems Study meeting at LPI on August 6-10.

The JSC Medical Operations Branch held a Health Maintenance Facility Advisory Group meeting at the LPI on August 6 and 7.

The JSC Space and Life Sciences Division held a Project Review meeting at the LPI on August 27-28.

The JSC Flight Crew Operations Directorate held Astronaut Candidate Training sessions at the LPI on August 27, 28, 30, and 31; September 4, 6, 7, 17-21, and 24-27; October 3-5 and 16-19; December 10-12.

A meeting of the Lunar Base Conference Steering Committee held a meeting at the LPI on September 17. The Conference, entitled "Lunar Bases and Space Activities of the 21st Century", took place in Washington, D. C. on October 29-31 (see Schedule G).

NASA/JSC conducted a debriefing of Shuttle 41-G Mission Astronauts at the LPI on October 15.

The JSC Institutional Data Systems Division/Mission Support held a Space Station Software Management Planning Workshop at the LPI on October 17-19.

USRA Headquarters conducted a planning meeting for University Programs in Advanced Mission Design at the LPI on October 24-25.

Ms. Rebecca McAllister conducted an Image Processing User's meeting at the LPI on November 6.

The JSC Systems Engineering and Integration Office held a senior level retreat at the LPI on November 8.

USRA's Division of Space Biomedicine held a meeting, chaired by Dr. Paul Coleman, at the LPI on November 13.

NASA/JSC conducted a debriefing of Shuttle 51-A Mission Astronauts at the LPI on November 19.

Dr. John Annexstad of JSC held a planning meeting at the LPI on November 20 to discuss the up-coming International Workshop on Antarctic Meteorites to be held in July 1984 in Mainz, Germany.

Dr. Sam Pool of the JSC Medical Sciences Division held a meeting at the LPI on November 27 to discuss the life science module for the Space Station.

Dr. D. Bogard/JSC, Discipline Scientist for Planetary Materials and Geochemistry, held a NASA Program Management meeting at the LPI on December 4.

The JSC Employee Development Branch held a Personnel Retreat at the LPI on December 5.

USRA's Division of Space Biomedicine held a meeting at the LPI on December 5.

The JSC Space Station Projects Office held a Technology Advocacy Group-F meeting at the LPI on December 5 and 6.

The Systems Development Branch of the Space and Life Sciences Directorate at JSC held a Module Research meeting at the LPI on December 20.

APPENDIX IV
LPI CONTRIBUTIONS AND TECHNICAL REPORTS

APPENDIX IV

LUNAR AND PLANETARY INSTITUTE CONTRIBUTIONS 1 JULY 1984 TO 31 DECEMBER 1984

- 537 PAPERS PRESENTED TO THE 47TH ANNUAL MEETING OF THE
METEORITICAL SOCIETY, JULY 30 - AUGUST 2, 1984
HOUSTON, LPI, 1984. 227 PP.
- 538 BROWN, L.L. + GOLOMBEK, M.P.
TECTONICS ROTATIONS WITHIN THE RIO GRANDE RIFT:
EVIDENCE FROM PALEOMAGNETIC STUDIES
JOURNAL OF GEOPHYSICAL RESEARCH. (TO BE PUBLISHED)
- 539 MCDONOUGH, W.F. + NELSON, D.O.
GEOCHEMISTRY OF THE PERALKALINE PAISANO VOLCANO, WEST
TEXAS; IMPLICATIONS FOR MAGMA PROCESSES
GEOCHIMICA ET COSMOCHIMICA ACTA (TO BE PUBLISHED)
- 540 LPI EDITORIAL BOARD
PAPERS PRESENTED TO THE CONFERENCE ON THE ORIGIN OF THE MOON
OCTOBER 13-16, KONA, HAWAII. HOUSTON, TEXAS, LPI,
1984. 71 PP.
- 541 BURKE, K. + KIDD, W.S.F. + KUSKY, T.M.
PONGOLA STRUCTURE OF SOUTHEASTERN AFRICA: THE WORLD'S
OLDEST PRESERVED RIFT?
JOURNAL OF GEODYNAMICS (TO BE PUBLISHED)
- 542 RUDNICK, R.L. + ASWAL, L.D. + HENRY, D.J.
+ GIBSON, E.K. + ROEDDER, E. + BELKIN, H.E.
+ COLUCCI, M.T.
FLUID INCLUSIONS IN STONY METEORITES -- A CAUTIONARY
NOTE
PROCEEDINGS 15TH LUNAR AND PLANETARY SCIENCE CONFERENCE
(TO BE PUBLISHED)
- 543 LONGHI, J. + ASHWAL, L.D.
TWO-STAGE MODELS FOR LUNAR AND TERRESTRIAL ANORTHOSITES:
PETROGENESIS WITHOUT A MAGMA OCEAN
PROCEEDINGS 15TH LUNAR AND PLANETARY SCIENCE CONFERENCE
(TO BE PUBLISHED)
- 544 MATSUI, T. + SCHULTZ, P.
BRITTLE-DUCTILE BEHAVIOR OF IRON METEORITES: NEW
EXPERIMENTAL CONSTRAINTS
PROCEEDINGS 15TH LUNAR AND PLANETARY SCIENCE CONFERENCE
(TO BE PUBLISHED)

- 545 ASHWAL, L.D. + WOODEN, J.L.
SM-ND ISOTOPIC STUDIES OF PROTEROZOIC ANORTHOSITES:
SYSTEMATICS AND IMPLICATIONS
PROCEEDINGS OF NATO ADVANCED STUDY INSTITUTE - THE DEEP
PROTEROZOIC CRUST IN NORTH ATLANTIC PROVINCES
(TO BE PUBLISHED)
- 546 GUST, D. + BIDDLE, K.T. + PHELPS, D.W. + ULIANA, M.A.
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- 547 BILLS, B.G. + KOBRICK, M.
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APPENDIX V
C²PDA NEWSLETTERS



Lunar & Planetary Institute

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NEWSLETTER

Number 2, August, 1984

Kinpong Leung, Editor

In this issue: Roger Phillips discusses the various aspects of the Geophysical Data Facility (GDF) and guides the reader through an interactive session with the LPI computer. In a following article, Peter Francis discusses some current research on volcanology at the Image Processing Facility (IPF).

GEOPHYSICAL DATA FACILITY

Introduction

The purpose of the Geophysical Data Facility (GDF) is to provide the scientific community with access to a number of large, global geophysical data bases for Earth, Moon, Mars, and Venus. By access we mean the ability to rapidly zoom in on a subset of a global data set, to display this subset in a variety of ways, and to easily model the data.

Mechanics of Accessing the GDF

The GDF is being designed primarily with the remote user in mind; i.e., we expect that the majority of users will access the system from their home terminals via modem connection. A graphics terminal is needed at the home institution, and at present, the terminal must be able to use DEC REGIS graphics software. Very soon GDF will also be able to work with Tektronics PLOT10 software. It is also possible to select color image output from the GDF program, but the image will be physically produced at the LPI. This can be pre-arranged by phone call, and the images will be mailed to you.

You will want to use the GDF program at 1200 baud because 300 baud will put you to sleep. Although we have recently taken steps to improve the situation, we still find the phone lines into LPI noisier than they should be. Hopefully, this situation will be corrected soon; at present it could take you several tries to pick up the carrier signal, but don't be discouraged. The LPI computer is free (to you), so your expense is going to be phone time. At present, you access the GDF by whatever long distance phone service is available to you. We are concerned that phone costs will become an inhibiting factor in using the GDF; we need feedback from the community on this. Commercial services are available (at a fixed monthly cost to LPI) that could significantly lower phone charges to the user.

Here's what you do to access the GDF:

- (1) Dial up the LPI VAX at 713-486-8214.
- (2) When you obtain the carrier, press RETURN on your keyboard.
- (3) After USERNAME: appears, type GDFLPI & press RETURN
- (4) After PASSWORD: appears, type GDF

You will now be in the GDF program. It is menu driven and self-explanatory. You should be able to use it without any external help. However, deep down inside we don't really believe this is totally true, and we are working on a

users' manual. If you become a serious user of the GDF, you will have your own account on the LPI VAX, and you will access the GDF program through this account. For human help with GDF, you should call Brian Fessler at 713-486-2184.

Data Sets

The current data sets on the GDF are Earth: Quarter-degree 1% images of SEASAT altimetry (over ocean) and of topography; Mars: Line-of-sight (LOS) gravity data; Venus: Quarter-degree topography and LOS gravity data. Data sets to be added ~~now~~ are Earth: MAGSAT data and satellite-to-satellite tracking (SST) gravity data.

Of the presently available data sets, the topographic and SEASAT data sets can be displayed as 3-dimensional maps or images. The present gravity data can also be displayed in profile mode, after selecting an interpolation option. The gravity data can also be displayed in profile format. At present, the Venus gravity data can be modeled by several functional representations of density distribution. The Mars gravity data will be able to be modeled as soon as we can enter the files of spacecraft state parameters.

An Example

One of our prime motivations for establishing the GDF was to bring to the scientific community the ability to access and quantitatively deal with orbital gravity data for the terrestrial planets. These are robust data sets that have only been dealt with by a small group of scientists because, we feel, of the difficulty of dealing with the orbital dynamic aspects of the data. The GDF attempts to remove this obstacle so that individuals can very nearly treat this data in the traditional way surface gravity data on Earth has been dealt with. It is natural that the present version of the GDF program is best developed in gravity display and modeling and this is the basis for the example that follows.

Figure 1 shows the screen display from the start of the GDF program through selection of Venus LOS gravity data. After specifying the creation of a new data file, the screen will appear as in Figure 2, showing the various ways of picking a subset of the global data set. The choices made are shown in Figure 3, which isolates a region centered on the Beta Regio area. In Figure 4 we have chosen a display of the global coverage of the selected data set. The ~~map's~~ appearance at the northern limit is due to the altitude cutoff criterion. We will skip the orbital profile data display and go directly to modeling. Figure 5 shows the screen at the start of the modeling run. Here we have chosen to model Beta Regio with a disk conforming to the curvature of the planet and to test the model against the observed LOS data of Orbit 567. The parameters entered for the model are shown at the bottom of

the screen display and at the top of the next screen display (Figure 6). After the output file is named the summary of the model ("CURVED DISK INPUT DATA") is displayed while the model output is being calculated. The results of the modeling, which takes the orbital dynamics into account, are shown in Figure 7 (dotted line) along with the observed LOS gravity data (solid line).

The subject of modeling in the GDF program is a lengthy discussion in itself and will be treated in the next issue of the C²PDA Newsletter.

Try It, You'll Like It (Maybe)

The above discussion is intended to lead you as gently as possible into the mysteries of the GDF program. We encourage you to try it and look forward to your comments when you do so. As you must suspect, the GDF software is in various stages of development and we are certainly in an experimental mode. Nevertheless, some parts of it are working very well and we are confident that you can use the present package to carry out serious research.

PLEASE ENTER INSTITUTION YOU ARE AFFILIATED WITH:
LPI

The Geophysical Data Facility has data for the following planets:

Earth
Venus
Mars

To exit this program just type <RETURN>

Which planet do you want to see?: VENUS

The following data types are available for Venus:

Data Type	Abbreviation
Line of Sight Gravity	LOS
Topography	TOPO

Enter abbreviation of desired data type: LOS

Fig. 1

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You have the option of constructing a new data file,
or using an already existing one.

What will it be? (OLD or NEW): NEW

PIONEER VENUS LINE OF SIGHT GRAVITY DATA

AVAILABLE DATA SELECTION OPTIONS:

1) SELECT ORBIT NUMBER(s)	DEFAULT: ALL ORBITS
2) SELECT ALTITUDE LIMIT	DEFAULT: ALL ALTITUDES
3) SELECT LATITUDE - LONGITUDE LIMIT	DEFAULT: ENTIRE SURFACE
4) SEARCH USING DEFINED SELECTION CRITERIA OR DEFAULTS	

SEVERAL OPTIONS MAY BE USED SIMULTANEOUSLY.
ENTER OPTION NUMBER:

OPTION: 1

Fig. 2

SEVERAL OPTIONS MAY BE USED SIMULTANEOUSLY.
ENTER OPTION NUMBER:

✓ OPTION:1
PVO ORBIT NUMBERS RANGE FROM 87 TO 634.
DISCRETE SET OR INTERVAL OF ORBIT NUMBERS:(S or I)
I ENTER FIRST AND LAST ORBIT OF INTERVAL:
830 634

OPTION:2
ENTER MINIMUM AND MAXIMUM ALTITUDE VALUES (KM):
0 1800

OPTION:3
LONGITUDE RANGES FROM -180.0 WEST TO +180.0 EAST
ENTER WEST-MOST AND EAST-MOST LONGITUDE VALUES:
-130 -30
LATITUDE RANGES FROM -90.0 SOUTH TO +90.0 NORTH
ENTER SOUTH-MOST AND NORTH-MOST LATITUDE VALUES:
-15 60

OPTION:4

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Fig. 3

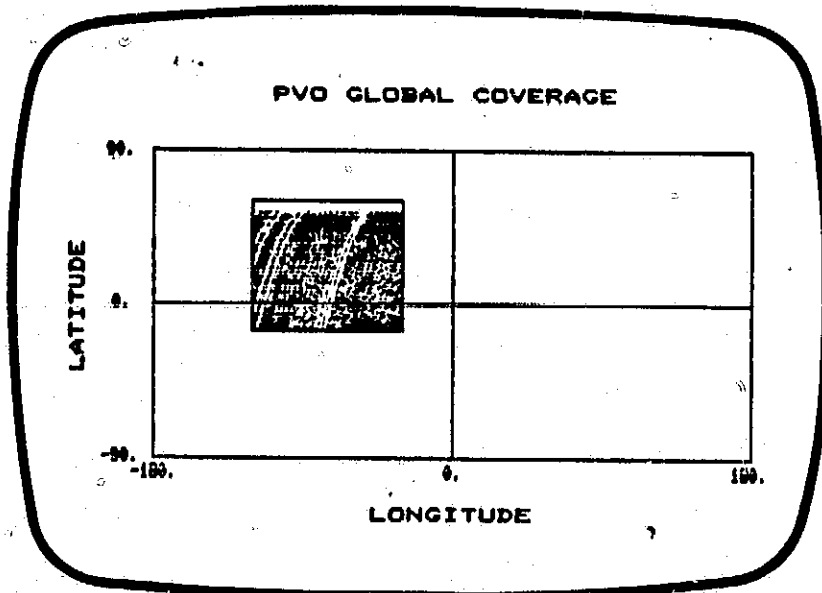


Fig. 4

THE FOLLOWING MODELS ARE AVAILABLE:

- 1) CURVED BORES (UP TO 10)
- 2) FLAT BORES (UP TO 10)
- 3) NAME POINTS (UP TO 10000)
- 4) SPHERICAL HARMONICS (UP TO DEGREE 20)
- 5) TOPOGRAPHY (UP TO 512 x 512)
- 6) QUIT

ENTER NUMBER OF MODEL TO BE USED: 1

CURVED BORE MODELLING OPTIONS:

- 1) RUN OLD MODEL (AS IN)
- 2) MODIFY OLD MODEL
- 3) CREATE NEW MODEL
- 4) QUIT

ENTER NUMBER OF OPTION TO BE USED: 1

ENTER NUMBER OF TRAJECTORIES TO BE MODELLED: 1

ENTER PVO ORBIT NUMBER OF TRAJECTORY # 1: 847

ENTER NUMBER OF CURVED BORES TO BE USED: 1

RADIUS OF BORE # 1 (KM) = 2000.0

LATITUDE OF CENTER OF BORE # 1 = 24.00

LONGITUDE OF CENTER OF BORE # 1 = -73.0

DEPTH OF BORE # 1 BELOW SURFACE (KM) = 0.0

NUMBER OF RINGS IN BORE # 1 = 5

Fig. 5

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STARTING WITH OUTER RING
 SURFACE DENSITY OF DISK # 1, RING # 1 (GM/CM**2) = -1.2805
 SURFACE DENSITY OF DISK # 1, RING # 2 (GM/CM**2) = -1.2805
 SURFACE DENSITY OF DISK # 1, RING # 3 (GM/CM**2) = -1.2805
 SURFACE DENSITY OF DISK # 1, RING # 4 (GM/CM**2) = 4.0805
 SURFACE DENSITY OF DISK # 1, RING # 5 (GM/CM**2) = 6.2805
 ARE THERE ANY ENTRY ERRORS YOU WISH TO CORRECT? (Y OR N): N
 WOULD YOU LIKE THESE MODEL PARAMETERS SAVED TO A PERMANENT FILE? (Y OR N): Y
 ENTER NEW MODEL FILENAME: QUAD2.DAT

CURVED ORBIT INPUT DATA

ORBIT #	SURFACE DENSITY	LATITUDE	LONGITUDE	DISTANCE BELOW SURFACE
1	3000.0000	24.0000	-71.0000	0.0000

DENSITIES OF RINGS	
RING NO.	DENSITY
1	-120000.00
2	-120000.00
3	-120000.00
4	400000.00
5	620000.00

Fig. 6

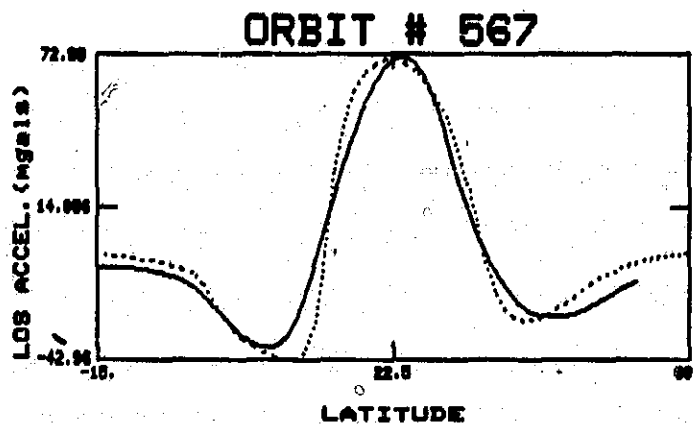


Fig. 7

IMAGE PROCESSING AND VOLCANOLOGY AT THE LPI

Over the last decade, imagery from LANDSAT satellites has provided an enormous new source of data on terrestrial volcanoes. While a certain amount of useful information can be extracted from black and white hard copy prints of LANDSAT imagery, to obtain the full value of the data contained in the image, digital image processing techniques are essential. At the LPI, a Gould/DeAnza system linked to the Institute's VAX computer is employed. Most of the research is concerned with applications of IP techniques rather than development of new ones.

Three main research themes are being pursued at present. First, identification and interpretation of large volcanic structures. Some classes of volcanic structures known as resurgent calderas are so large, of the order of 30-40 km, that they may be difficult to identify from ground studies, being camouflaged by their own scale. This applies in particular, of course, to remote regions where detailed studies are unavailable, and at present work is concentrated on the high part of the Central Andes, between 14 and 28 deg S, and the Tibetan plateau. Several large calderas between 20 and 2 million years old have been identified in the Andes, and some of them have been investigated subsequently in the field. An important spin-off of the work in the Andes and Tibet is a better appreciation of the relationships between volcanic activity and the regional tectonic setting.

Detailed studies of volcanic areas require knowledge of the age and composition of the rocks concerned, and this forms the second research theme. Work is under way to establish to what extent satellite imagery can be used to discriminate between lavas and pyroclastic flow units of different ages and compositions, and involves correlation of data from known flows in well mapped areas with their multispectral LANDSAT signature. Numerous environmental factors, particularly local climate, affect the radiometric characteristics of the rocks, and a programme of field radiometry of some Andean lavas is helping to place constraints on some of these factors.

Radiometrically, some of the most distinctive types of volcanic rocks are those associated with hydrothermal activity, and these form the third line of research. At the

simplest level, presence of areas of altered rocks in the summit regions of volcanoes in arid areas can be used as a guide to the level of fumarolic activity that is or has been in progress, and has some economic application in prospecting for sulphur. More importantly, many important copper and silver deposits are related to hydrothermal alteration processes taking place late in the evolution of volcanic structures. Work is in progress to characterise the nature of such hydrothermally altered areas, and to identify specific structural sites where alteration is likely to be concentrated. A number of previously unidentified areas have been detected on caldera ring fractures in the Andes, and these studies have been important in elucidating for the first time the setting of some important mineral deposits, notably that of Cerro Rico silver deposit in Bolivia.

In addition to these general themes, image processing is used in a number of special applications. An example which is currently undergoing investigation is the study of the debris avalanche deposits of Socompa volcano, north Chile. This 6000 m high volcano experienced a massive collapse at some point between 10,000 and 500 years ago, somewhat similar to that of Mt. St. Helens in May 1980, but on a much larger scale. About 10 cubic kilometers of the volcanic cone collapsed to form a massive landslide covering some 400 km². The avalanche deposits are amongst the most extensive known on Earth, and contain a number of distinct lithologies. Classification techniques are being employed to discriminate the major lithologies, and to relate each lithology to its original location on the volcanic structure. Since the region is extremely remote and difficult of access, satellite imagery and image processing offer the only means of studying this exceptional deposit.

ACCESS TO C²PDA

C²PDA is dedicated to access and utilization by the earth and planetary science community. We encourage both onsite visits as well as remote access through dial-in modems. For further information, please contact

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Lunar & Planetary Institute

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NEWSLETTER

Number 3, November 1984

Kinpong Leung, Editor

GEOPHYSICAL DATA FACILITY DEMO AT THE AGU

C²PDA will be demonstrating the remote access capabilities of GDF, the Geophysical Data Facility, during the Fall AGU meeting in San Francisco. Since the announcement of the log-on procedure in our last newsletter, we have had a very favorable response from the scientific community. In order to bring this remote access capability to a wider audience, we are setting up a series of demonstrations at the Americana Hotel (121 Seventh Street, 3 blocks from the Civic Auditorium) during the week of the AGU (December 3-6) in San Francisco. During the demo, you will be able to access the LPI databases just as you would in your home institutions. Access to the LPI databases and modelling programs is free. Current collections include earth topography, SEASAT, MAGSAT, GEOSAT, Venus topography and LOS (line of sight) gravity, Mars topography, Mars LOS gravity, and the Lunar Consortium datasets. Please inquire at the front desk of the Americana Hotel as to the exact time and room number for the demo sessions.

See you in San Francisco.

GRAVITY MODELLING WITH THE GDF

—Bruce Bills

The purpose of this article is to explore some of the possibilities for modelling of planetary gravity data available to the remote user through the GDF. After a brief discussion of various aspects of modelling in general, and gravity modelling in particular, we will describe in some detail the present and projected capabilities of the GDF.

In general, the objective of modelling is to obtain a mathematical representation of some physical system which helps to explain some observational data. A model thus usually consists of a set of parameter values and some equations relating the parameters to the observations. In forward modelling, the parameters are specified in advance and the appropriate equations are used to calculate the data values implied by the model. A comparison between the observed and calculated values yields either confirmation of the initial model or suggests changes in some of the parameter values.

In inverse modelling, the observational data are used directly to obtain estimates of the parameters. As an example, one might specify the location of a series of point masses and use the observed gravity data in the region of interest to estimate mass values which best

reproduce the observations.

Among the techniques available for gravity modelling, we can distinguish at least two broad categories, which we will term global and local. In what is perhaps the classic example of a global model, the gravitational potential is expressed as a spherical harmonic series. Examples of spherical harmonic models for the terrestrial planets are: Earth (Rapp, 1977), Moon (Bills and Ferrari, 1980), Mars (Balmino et al., 1982), Venus (Williams et al., 1983). The effective resolution of such a model is everywhere the same. This may be somewhat disadvantageous in situations where the resolution of the data is very uneven. Another type of model which is well suited to global applications consists of harmonic spline functions (Shure et al., 1982). The potential in this case is represented as the sum of contributions from basis functions, whose locations can be adapted to the distribution of data at hand. The GDF currently supports spherical harmonic modelling and we are developing the programs necessary for harmonic spline models.

An important difference in the "local" models is that, rather than directly specifying the gravitational potential, the user specifies a distribution of mass. The simplest such model uses point masses. Examples of point mass modelling include Ananda (1977), and Sjogren et al. (1971, 1975, 1983). On the GDF, you can specify the location (radius, latitude, and longitude) and mass (grams or fraction of planetary mass) of up to 15,000 distinct point masses. Obviously, it would be very tedious to enter that many values by hand. Fortunately, you also have the option of automatically converting topography for the area of interest into equivalent point masses (user specifies the volume density of the surface material).

For more coarse-grained modelling, you can also use disks. They come in two varieties: flat and curved. The curved disks are actually spherical caps and are useful when the disk is large enough and/or shallow enough that the edges of a flat disk would protrude above the surface of the planet. Examples of disk modelling applied to the planets include Sjogren et al. (1975, 1976).

Once a set of model parameters is specified, and a set of observational data is selected, the next step is to compare the accelerations implied by the model with those actually observed. For this purpose we use the orbit simulation program ORBSIM, which was developed at the Jet Propulsion Laboratory by Phillips et al. (1978). It takes an orbital state vector (initial position and velocity of the spacecraft) and numerically integrates the orbit, subject to the model accelerations. The acceleration vector is

projected to the line of sight (LOS) direction. This makes the model output directly comparable to the observed LOS gravity data. As originally implemented, ORBSIM was a powerful program, but rather difficult to learn how to use. The GDF Implementation has put ORBSIM in a relatively user-friendly, menu-driven environment. A prospective user need not know how the parameter files are structured, for example. All that is required is that you make appropriate responses to the questions the program asks (see example in the previous newsletter).

At present the GDF version of ORBSIM is limited to forward modelling, but the inverse modelling capability will be implemented in the near future. We hope that you will give it a try. We also welcome suggestions on how we can make the system more flexible and easier to use.

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TEKTRONICS PLOT 10 SUPPORTED

As promised in the last newsletter, Tektronics Plot 10 software is now supported by GDF. This means that a user running REGIS graphics software, or any graphics terminal that runs Tektronics Plot 10 software as well as any DEC VT125, VT240, or VT241 graphics terminal, can access the full graphics capabilities of GDF.

NOISY DIAL-IN LINE PROBLEM CORRECTED

The telephone company has finally corrected the problem on our noisy 300/1200 baud dial-in line (486-8214). We have had excellent feedback from our long distance users. In order to provide better access, a second 300/1200 baud line has been added. The 2 numbers are 486-8214 and 486-2183.

ACCESS

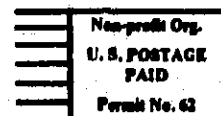
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APPENDIX VI
MECA NEWSLETTERS



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MECA

Newsletter

May 1984

Number 1

NEW MARS PROGRAM

Welcome! This newsletter is to announce the initiation of the new NASA-sponsored LPI study project entitled "Mars: The Evolution of its Climate and Atmosphere" (MECA) as defined in the Space Science and Applications Notice dated 25 May 1983. The overall goals of this program are given below.

An organizational meeting was held at the Lunar Planetary Institute on March 10-11, 1984. As stated in the Space Science and Applications Notice, the coordination of this program is in itself an experiment and is accomplished by a Working Group composed of all the investigators who are funded as part of the program. The first order of business was to establish a Steering Committee (see inset) and to define some general guidelines. Discussion by the Working Group led to the following decisions:

1. *The Study Group* is open to all investigators (funded either through MECA or elsewhere) who have potential contributions toward understanding the volatile evolution and climate history of Mars (see article on *Participation in MECA*).
2. *The Steering Committee* is selected from the Working Group, plus one member from the Study Group as a whole. The function of the Steering Committee is to define scientific questions as the program evolves and to provide guidance to the Projects Office.
3. *The Projects Office* is part of the Lunar and Planetary Institute. Its function is to provide administrative and logistical support, including making arrangements for various topical conferences and workshops.
4. *The Approach* in meeting the objectives of MECA will be to guide the research through a series of *Topical Workshops/Conferences*, each of which will have focused objectives. These workshops will be defined early enough so that investigators may plan their research efforts

accordingly. Approximately five topical workshops/conferences will be held during the three-year duration of the program.

Research will be conducted by individual investigators as stated in their approved proposals; in addition, informal collaboration, such as the formation of research groups, is encouraged. Funds (albeit limited) are available for travel to hold small workshops to address more narrowly focused subjects than those defined by the topical conference/workshops. These may be open to the Study Group as a whole, or by invitation only. Proposals for small workshops may be submitted to the Steering Committee through the Projects Office.

5. *Publications*. The principal mode of reporting MECA results will be via journal publication. Topical conference programs will be derived from abstracts submitted prior to the conference. In most cases, arrangements will be made to publish conference results in special journal issues. Some of the study group members may wish to produce review papers focusing on our present state of knowledge concerning the questions raised during subgroup discussions.

6. *MG/CO Connection*. Most of the goals of MECA are directly relevant to the Mars Geoscience/Climatology Orbiter. As plans for the mission develop, communication will be maintained through Mike Carr, MECA-Steering Committee member and Chairperson for the MG/CO Working Group.

In summary, we look forward to a stimulating program dealing with an exciting topic. On behalf of the Steering Committee, I solicit your support to make this program a success.

Ron Greeley
Chairperson, MECA-Steering Committee

5. What observations and modeling will help resolve 1-4?

Examples:

- changes in crater morphology with location and time
- valley origin and changes in valley morphology with location and time
- mineralogic/chemical mapping
- thermal modeling of regolith
- studies of kinetics of volatile migration
- experimental weathering studies

Bulk Chemical Composition and Outgassing History

- What is the range of possible absolute and relative abundances of the initial Mars volatile inventory?
 - Status of geochemical modeling from nebular condensation assuming thermodynamic equilibrium (function of pressure-temperature, radial distance from sun, nebular composition)? Status of geochemical modeling from multicomponent mixing of meteoritic volatile and nonvolatile components? Status of geochemical information from geophysical modeling?
 - What new information or modeling constraints on existing volatile inventories in the martian mantle can be obtained from the SNC meteorites, accepting the evidence associating them with Mars?
- What evidence exists that the planet has undergone significant oxidation? Is the oxidation only on the

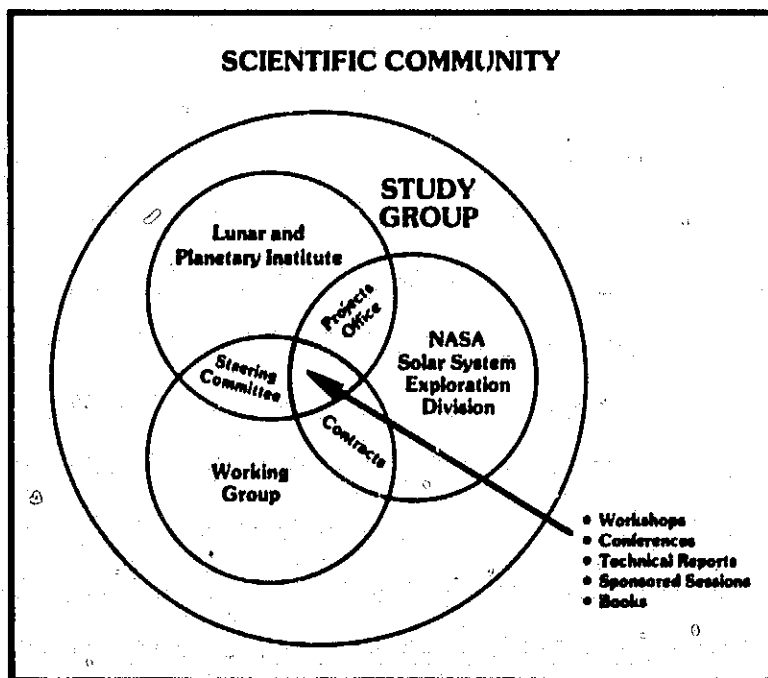
surface? Are there plans to try to measure martian atmospheric D/H? Has the composition of degassed volatiles changed with time?

- Styles of volcanism in time and space (inputs from climate history/ surface morphology)?
 - Information from styles of eruption on volatiles in magma? On sizes and depths of magma chambers?
 - How do we evaluate the effectiveness of various degassing mechanisms and processes (free or excess volatiles, volatiles dissolved in magmas, eruption and subsequent oxidation of species such as FeS and C)?

- What does the present atmosphere tell us about integrated outgassing, modified by loss processes to the regolith and to space over martian geologic time? Implications of isotopic signatures ($^{15}\text{N}/^{14}\text{N}$, $^{129}\text{Xe}/^{132}\text{Xe}$, $^{40}\text{Ar}/^{36}\text{Ar}$)?

REVIEW PAPERS

The questions raised by the four subgroups may stimulate members of the Study Group to identify and perhaps to consider writing review papers that would summarize our present state of knowledge. Several excellent review papers, special journal issues, and books already exist, but the readership may identify areas that have not been previously synthesized or old areas that would benefit from a different perspective or focus. Although it is not the purpose of the study project to presuppose the



STEERING COMMITTEE

- Ronald Greeley, Arizona State University,
Chairperson
Michael Carr, U.S. Geological Survey (Surface Processes)
Fraser Fanale, University of Hawaii (Climate Change)
Robert Haberle, NASA-Ames Research Center (Seasonal Cycles)
Robert Pepin, University of Minnesota (Bulk Chemistry)
Peter Schultz, Lunar and Planetary Institute (Project Scientist)
- Joseph Boyce, NASA Headquarters (ex officio)
Kevin Burke, Lunar and Planetary Institute (ex officio)
Pam Jones, Lunar and Planetary Institute (Project Administrator)

outcome of the next three years of research and scientific interaction, such reviews may prove useful for group members with diverse backgrounds but common goals. Individuals or groups of individuals are encouraged to embark on such an effort and may wish to contact R. Greeley about the matter. Obviously, the purpose of the project is to do science rather than to do review papers; nevertheless, the group would benefit by dedicated individuals wishing to complement their research.

Recent Review Articles

1. Carr M. H. (1982) Periodic climate change on Mars: review of evidence and effects on distribution of volatiles. *Icarus* 50, 129-139.
2. Carr M. H. (1981) *The Surface of Mars*. Yale University. 232 pp.
3. Baker V. R. (1982) *The Channels of Mars*. U. Texas Press. 198 pp.
4. Fanale F. P. and Jakosky B. M. (1982) Regolith-atmosphere exchange of water and carbon dioxide on Mars: Effects on atmospheric history and climate change. *Planetary and Space Science* 30, 819-831.
5. Fanale F. P., Salvai J. R., Banerdt B. W., Saunders R. S. (1982) Mars: The regolith-atmosphere-cap system and climate change. *Icarus* 50, 381-407.
6. Pollack J. P. (1979) Climatic change on the terrestrial planets. *Icarus* 37, 479-553.
7. Pollack J. P. and Toon O. B. (1982) Quasi-periodic climate changes on Mars: A review. *Icarus* 50, 259-287.
8. Rossbacher L. A. and Judson S. (1981) Ground ice on Mars: Inventory, distribution, and resulting landforms. *Icarus* 45, 35-39.
9. Toon O. B., Pollack J. B., Ward W., Burns J. A. and Bilski K. (1980). The astronomical theory of climate change on Mars. *Icarus* 44, 552.
10. Ward W. R., Burns J. A. and Toon O. B. (1979) Past obliquity oscillations of Mars: Role of the Tharsis uplift. *Journal of Geophysical Research* 84, 243-259.

MECA PROGRAM SCOPE

For the benefit of readers not aware of the Space Science and Applications Notice of May 25, 1983, we include below an excerpt describing the scope of the program. Although the problem is focused, the number of different approaches and basic data sets requires involvement from a variety of disciplines.

The Mars Data Analysis Program will support a variety of scientific investigations in a focused study that will address the provenance and evolution of martian volatiles. The goals of the study are to define the present

inventory and distribution of martian volatiles and to unravel the history of their evolution so that we may understand the original volatile content of Mars as inherited from the proto-planetary nebula; the processing of primary volatile components by the martian interior; the evolution of the martian atmosphere; the interchange between the surface and the atmosphere through geologic time; and secular or non-secular changes in climate and the processes responsible for any changes. Proposed investigations that directly address any of the above stated goals or that will contribute to the attainment of them will be considered scientifically responsive to this Notice.



"WATER ON MARS" THE FIRST TOPICAL CONFERENCE ABOUT MARS:

The Evolution of its Climate and Atmosphere

The first MECA topical conference will be held Friday and Saturday (November 30 and December 1) prior to the Fall American Geophysical Union meeting in San Francisco. The two-day meeting will be hosted by Bob Haberle at NASA Ames Research Center. Although the detailed format of the meeting is still being formulated, contributed papers from the Study Group probably will form the core of the program. "Water on Mars" represents one of the fundamental issues that the MECA Study Group must face. What is the evidence for the existence of water in the past? How much water was there? Where is it today? How did it evolve? What is the physical state of water and how has it changed? Such questions should generate active participation and perhaps a better understanding of the problem.

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MECA

Newsletter

September 1984

Number 2

"WATER ON MARS": THE FIRST MECA-LPI SPONSORED WORKSHOP

As part of the new NASA-sponsored LPI Study project entitled "Mars: The Evolution of its Climate and Atmosphere" (MECA), a workshop will be held Friday and Saturday (November 30 and December 1) prior to the Fall American Geophysical Union meeting in San Francisco. The two-day meeting will be co-hosted by the NASA Ames Research Center, represented by Bob Haberle, and the Lunar and Planetary Institute.

In order to assess the origin and history of water on Mars and its role in the evolution of the climate and atmosphere, the workshop will focus on four key questions:

1. What is the present water cycle and what processes affect this cycle?
2. How has the water cycle changed in the past and what can be inferred about past climates?
3. What are the nature and distribution of the sources and sinks for water at the surface today and how have they changed with time?
4. What are the current and past bulk water contents?

Each participant will be expected to furnish an abstract (maximum of 3 pages) that will be incorporated into an abstract volume to be issued before the start of the workshop. Although the detailed format of the meeting is still being formulated, contributed papers from the Study Group will probably form the core of the program. These papers will be presented in consecutive half-day sessions devoted to a discussion of

each of the four key questions. Participants in the meeting are strongly encouraged to take advantage of the provisions for posters and displays which have also been made.

Those who are interested in participating in the workshop should contact the Projects Office (telephone 713-486-2150) by September 21, 1984. Abstracts should be received in the LPI Publications Office no later than October 26, 1984.

IAMAP SYMPOSIUM: "COMPARATIVE CLIMATOLOGY OF THE TERRESTRIAL PLANETS"

As part of the IAMAP/IAPSO Joint Assembly (International Association of Meteorology and Atmospheric Physics/International Association for the Physical Sciences of the Ocean) to be held in Honolulu between August 5 and 16, 1985, there will be a symposium entitled "Comparative Climatology of the Terrestrial Planets." Phil James, Convenor of the symposium, anticipates that most of the papers presented at the conference will deal with Mars. Papers generated as a result of the symposium will be considered for publication in a special issue of *Icarus*. Scientists who are interested in participating in this conference should address their inquiries to: Joint Assembly, American Geophysical Union, 2000 Florida Avenue, N.W., Washington, D.C. 20009, telephone 202-462-6903, twx 710-822-9300, Telemail BWEAVER (Meetings Manager).

VIEWPOINT: A DIRECT LINE TO THE MEGA STUDY GROUP

Beginning with the next issue, the MECA Newsletter will include a regular column called **VIEWPOINT** which will serve as a means for participants to communicate ideas, suggestions, and criticisms, both among themselves and the Study Group at large. Potential topics for discussion might include suggestions for areas of new or cooperative research, possible changes in MGCO or follow-on mission objectives, experiments, and procedures, or practical tests of various assumptions, theoretical models, and morphologic interpretations. Where significant differences of opinion exist, opposing points of view will be actively solicited. All submissions should follow the guidelines outlined in **NEWSLETTER CONTRIBUTIONS**.

THE MARS GEOSCIENCE/CLIMATOLOGY OBSERVER (MGCO) MISSION

The Mars Geoscience/Climatology Observer Mission is to be the first in a series of modest cost inner planet missions. This mission is included in the approved 1985 fiscal year NASA budget with a formal start on 1 October 1984. Launch is planned for the August/September 1990 Mars opportunity with arrival at Mars one year later. The Geoscience/Climatology objectives are to be met over the course of a one Mars year (687 day) mapping mission. The mapping orbit will be near-polar (93 degree orbital inclination), synchronous (2 PM sunward equator crossing), and near-circular (350 km orbit altitude, 116 minute period). The spacecraft, to be selected in 1985, will maintain a nadir orientation. Experiments and instruments will be selected through an Announcement of Opportunity (AO) process with release of the AO in July 1985 and selection in 1986.

All the scientific measurement objectives involve global mapping in space and time and include:

1. Determination of the global elemental and mineralogical character of the surface material;
2. Determination of the time and space distribution, abundance, sources, and sinks of volatile materials and dust over a seasonal cycle;

3. Definition globally of the gravitational field and surface topography;
4. Exploring the structure and aspects of the circulation of the atmosphere; and
5. Establishing the nature of the magnetic field.

Fulfillment of these objectives will provide information of direct relevance to understanding the evolution of the Mars climate and atmosphere, which is one of the major goals of this mission. The Project Scientist for MGCO is Arden L. Albee of Caltech and the Project Manager is William I. Purdy of JPL. The MGCO Science Working group is headed by Michael Carr and consists of twenty representatives from the planetary sciences community. Less than one year remains before release of the AO to supply instrumentation and define experiments for MGCO, the next United States Mission to Mars.

—Frank Don Palluconi

THE CASE FOR MARS II

The Case for Mars II, sponsored by the Mars Institute of the Planetary Society, was held July 10-14, 1984, at the University of Colorado, Boulder, Colorado. The conference/workshop was conducted to evaluate a manned base of Mars, using current and immediately foreseeable technology. Attending were over 150 participants who represented a broad range of disciplines, ranging from the physical sciences, aerospace engineering, and space medicine, to economics and even political science. Reviews of the key science and technology issues relevant to manned Mars missions were presented in plenary sessions. Participants then designed a plan for Mars exploration which included the establishment of a permanent base.

One of the conclusions reached by the participants is that a manned base on Mars could be an unifying goal for the space program. The Space Transportation System, or space shuttle, could boost Mars vehicle components into low Earth orbit where the spacecraft would be assembled and serviced by workers living in space. Knowledge gained in near-Earth orbit living quarters and space station recycling systems would be directly applied to the years-long Mars missions and subsequent bases.

Missions in the planning and development stages today lay the foundation for future perm-

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anent Mars bases. Important for resource assessment, a global inventory of surface and atmospheric volatiles and chemistry will be obtained by the Mars Geoscience Climatology Observer (MGCO). If high-resolution imaging were included with this mission, geologic mapping for site selection could also be accomplished. MGCO will not be able to detect subsurface ground ice at depths greater than 10 cm, so an orbital mission with the ability to detect deeply buried, subsurface ice is a needed technological development.

A Mars base provides one of the most exciting scientific challenges ever presented. Direct, comprehensive exploration of a planet similar to Earth will be possible for the first time in history—a planet replete with atmosphere, available water, and unique geochemical processes. Though not inexpensive, the rewards to all the sciences will be immeasurable, as will the applicable technology developed for the permanent base and martian spacecraft. The cost of a single manned landing on Mars has been estimated (using current technology) to be about \$40 billion. Long-range program planning at NASA currently calls for a real budget increase of 1% annually. Based on this budgetary framework, a Mars base could be established around the year 2025.

The proceedings for The Case for Mars II will be published by the American Astronautical Society in the Science and Technology series, available by the summer of 1985. For further information, write to: The Case for Mars, P. O. Box 4877, Boulder, Colorado 80306.

—Carol Stoker and Loretta McKibben

MECA PROJECT SCIENTIST CHANGE AT LPI

Pete Schultz, Senior Staff Scientist at LPI, has accepted an academic position with the Department of Geological Sciences at Brown University. Although he will remain an active participant in the MECA program, his duties as the Institute's scientific representative on the MECA Steering Committee and as editor of the MECA Newsletter have now been passed on to Steve Clifford. Steve, who has been a member of the scientific staff at LPI since January, will be responsible for maintaining the active interaction among the Working Group, Study Project, Steering Committee, Pro-

jects Office and the LPI. Steve's involvement in the MECA program is a natural outgrowth of his ongoing research in the field of martian volatiles. His specific interests focus on the evolution of the martian polar caps, the physics of water transport in the regolith, and the possible role that ground-water played in the distribution and subsurface replenishment of equatorial ground ice. Steve's telephone number at the Institute is 713-486-2146.

MARS BIBLIOGRAPHY AVAILABLE AT THE LPI

The Library Information Center (LIC) at the Lunar and Planetary Institute has maintained an on-line bibliography of the lunar and planetary literature for several years. In the initial stage, the bibliography was totally lunar, but since 1978, references to the planets, meteorites, asteroids, comets, and some references to space industrialization and utilization are included.

A recent search of the bibliography has yielded 978 references to the planet Mars. Using the boolean logic operators which are available on the database, it was found that 293 of these citations contain some additional reference to climate "or" water "or" atmosphere. Of course, additional topics relating to martian surface properties, chemical composition, etc., also can be searched on the database.

As each reference is added to the database, the text is scanned for subject terms already included in the database's controlled search vocabulary; in this way, searches are not simply limited to keywords present in the title. The database may also be searched by author and year of publication.

The bibliography is on-line on the Institute's VAX 11/780. It can be accessed remotely using a modem and most standard terminals. The staff of the LIC will also respond to requests for searches, either written or phone in, and will send a print-out of the results, usually within 48 hours of receipt of the search. There is no charge for this service other than your telephone charges if you should access remotely.

To receive more information about the bibliography or to establish a remote user account, contact Stephen Tellier at the LPI (telephone 713-486-2191).

REVIEW PAPERS ON MARS

Carr, M. H. (1983) The geology of the terrestrial planets. *Reviews of Geophysics and Space Physics* 21, 160-172.

Greeley, R. and Spudis, P. D. (1981) Volcanism on Mars. *Reviews of Geophysics and Space Physics* 19, 13-41.

Squyres, S. W. (1984) The history of water on Mars. *Annual Reviews of Earth and Planetary Sciences* 12, 83-106.

Newsletter 3 Contribution Deadline: 12/21/84

NEWSLETTER CONTRIBUTIONS

In an effort to keep participants in the Study Group informed about the latest meetings, activities, and other news that are related to MECA's goals and Mars in general, contributions to the MECA Newsletter are cordially invited. Contributions should be brief and should be written in a "newsletter style." Submissions may be type-written or sent on floppy disk (5¼" IBM PC or TI Professional format) in the standard ASCII MS-DOS text files. Provisions for the direct

reception of text, transmitted by phone, will be available shortly at LPI. All contributions should be sent to Steve Clifford, MECA Newsletter, Lunar and Planetary Institute, 3303 NASA Road 1, Houston, Texas 77058.

MECA: PROGRAM SCOPE AND PARTICIPATION

The goals of the MECA program are to define the present inventory and distribution of martian volatiles and to unravel the history of their evolution so that we may understand the original volatile content of Mars as inherited from the proto-planetary nebula, the processing of the primary volatile components by the martian interior, the evolution of the martian atmosphere, the interchange between the surface and atmosphere through geologic time, and any secular or nonsecular changes in climate and the processes responsible for such changes.

Any scientist whose research is relevant to the goals of MECA, but whose funding originates from outside the program, is invited to join the Study Group. Simply write to the Steering Committee through the LPI Projects Office outlining the nature of the relevant research. Your name will then be added to the mailing list.



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